



CHLORINATED HYDROCARBON CONCENTRATIONS IN THE GULF OF CALIFORNIA
HARBOR PORPOISE (PHOCOENA SINUS)

Final report for Contract MM4465846-3 from:

Marine Mammal Commission
1625 I Street NW. Rm. 307
Washington D.C. 20006

Prepared by:

John Calambokidis
Cascadia Research
218½ W. Fourth Ave.
Olympia, WA 98501

10 August 1988

TABLE OF CONTENTS

	Page
Introduction	1
Methods	2
Results and Discussion	3
Conclusions	10
Aknowledgments	11
References	12
Appendix - Individual test results	16

INTRODUCTION

High concentrations of chlorinated hydrocarbon contaminants have been noted in coastal odontocetes from a number of areas (Gaskin et al. 1971, 1974, 1982, 1983, Calambokidis 1986, Calambokidis et al. 1984, O'Shea et al 1980, Taruski et al. 1975). Many of these contaminants are stable, tend to concentrate up food chains, and are lipophilic accumulating in fatty tissues such as blubber. Coastal odontocetes occurring in nearshore waters near industrial or agricultural areas are particularly susceptible to accumulation of these contaminants. Impacts of chlorinated hydrocarbons on wild marine mammal populations have been hard to demonstrate conclusively because of the complexity of proving such a relationship in an uncontrolled environment. A number of studies have documented apparent relationships between chlorinated hydrocarbons (PCBs or DDE) and reproductive difficulties in pinnipeds (Helle et al. 1976a, 1976b, Gilmartin et al. 1976, Reijnders 1982a, 1982b). A recent study with captive seals has demonstrated a cause and effect relationship between reproductive failure in harbor seals and consumption of fish from a contaminated area (Reijnders 1986).

The Gulf of California harbor porpoise (Phocoena sinus) also known as cochito and vaquita is restricted to the northern waters of the Gulf of California (Brownell 1983, 1986, Brownell et al. 1987). The limited range of this species and low population size underscores the importance of research on this species. A series of tissues recently became available from 13 fresh animals examined in 1985 and described in Brownell et al. (1987).

This report summarizes results of analysis for chlorinated hydrocarbon concentrations in the blubber of eight vaquita. These results will be incorporated into a publication authored by the individuals involved in the collection and analyses of these samples.

METHODS

Samples were collected as described in Brownell et al. (1987). Tissues samples were collected in aluminum foil and stored frozen. During shipment some of the samples thawed but remained chilled. Because the samples were transported between a number of locations this may have occurred on several occasions.

Blubber samples from eight vaquita were analyzed for pesticides and PCBs by Analytical Resources Inc. (ARI), an EPA contract laboratory in Seattle, Washington. All tissue samples were received frozen by ARI and maintained at -20°C until thawed for extraction.

Sample Extraction: After thawing, 10 ml of methylene chloride (CH_2Cl_2) was added to each sample. The samples were then ground into a paste using a Tekmar Tissumizer, and 25 grams of sodium sulphate (Na_2SO_4) was blended into each sample. Another 50 ml of CH_2Cl_2 was added, along with 200 μl of the surrogate standard solution containing 12 μg of d8-naphthalene, 15 μg of d10-acenaphthene, and 11 μg of d12-perylene. The entire sample mixture was then homogenized using the Tissumizer on high speed for one minute. The solvent portion was decanted off, passed through more Na_2SO_4 , and collected in a prepared Kuderna Danish (KD) concentration apparatus. Each sample was similarly extracted three additional times (making a total of four) and the extracts composited in the KD. Each sample was then concentrated to approximately 10 ml.

GPC Cleanup: Sample extracts were injected on a Biobeads SX-3 column (2.5 cm id x 55 cm) and eluted with CH_2Cl_2 at 5 ml per minute. The column was calibrated with a mixture of corn oil, ethylhexyl phthalate, and pentachlorophenol. A single fraction containing all of the targeted compounds was collected, and the fraction containing the higher molecular weight compounds was discarded. The fraction collected was then concentrated to 1 ml using the water bath and evaporator as before.

Alumina Cleanup: The extract was passed through an alumina column containing approximately 3 grams of alumina. The extracts were eluted with a solution of 10% CH_2Cl_2 in hexane and a 10 ml volume was collected.

Pesticide/PCB Analysis: Following alumina cleanup, approximately 1 ml of each 1:10 extract was analyzed for pesticides/PCBs by GC/ECD using a 30 meter, DB-5 silica column. The results from the DB-5 column were then confirmed using a DB-1701 (14% cyanopropylphenyl) column.

RESULTS AND DISCUSSION

Results of analyses are summarized in Table 1 with detailed results included in the Appendix. Concentrations of only four pesticide related compounds and PCBs exceeded detection limits (see Appendix). DDE (4,4'-DDE), the primary breakdown product of the pesticide DDT, was the only pesticide recovered from all samples with concentrations ranging from 530 to 7,500 ppb (ug/kg by wet weight). Concentrations based on lipid weight are only slightly higher because samples consisted of 67 to 100% lipids. Two other DDT-related compounds were also recovered, DDD (4,4'-DDD) and DDT (4,4'-DDT), though in much lower concentrations than the DDE. Five samples contained detectable concentrations of DDD, ranging from 34 to 600 ppb and four samples contained detectable concentrations of DDT, ranging from 50 to 1,000 ppb. Both DDD and DDT concentrations were significantly correlated with DDE concentrations ($r=.82$, $p<0.01$ for both cases). Alpha-BHC was only detected in three samples at concentrations of 5 to 49 ppb. PCBs were detected in a single animal at 200 ppb.

Concentrations of total DDT (4,4'-DDE + 4,4'-DDD + 4,4'-DDT) in relation to sex and lengths of porpoise are shown in Figure 1. Though sample size is small, the results suggest several patterns consistent with findings in other marine mammals. Concentrations appear to increase with length in males with the highest concentration in any animal occurring in the only mature adult male. Concentrations in subadult females are similar to the males but the three adult females showed concentrations that were lower than the subadult females and dramatically lower than the single adult male.

This pattern is consistent with studies of concentrations in other marine mammals. Increasing concentrations of DDT compounds and PCBs in males with age or length has been reported for pinnipeds (Calambokidis et al. 1984, Addison and Smith 1974, Addison et al. 1973, Donkin et al. 1981) and odontocetes (Gaskin et al. 1982, 1983). Concentration increases in females have generally been found to remain constant or decline once reproductive age is reached (Gaskin et al. 1982, 1983, Calambokidis et al. 1984, Addison and Smith 1974). These results reflect the low rates of metabolism and excretion of these compounds with adult females being able to partially purge these compounds through transplacental transfer and lactation.

Concentrations of both DDT compounds and PCBs were generally lower than has been reported for odontocetes in many areas (see Risebrough 1978, Calambokidis et al. 1984, and Wagemann and Muir 1984 for reviews). Table 2 and Table 3 show concentrations of total DDT and PCBs, respectively,

Table 1. Concentrations of chlorinated hydrocarbons in Phocoena sinus recovered from the Sea of Cortez, Mexico in 1985. Life history data from Brownell et al. (1987).

No.	Date Mo/Dy/Yr	Sex	Mat.	Wt. Kg	Leng. cm	Girth cm	Perc. Tipid	Concentration (ug/kg, wet weight)						
								ppDDE	ppDDD	ppDDT	TDDT	A-BHC	PCB	
3	3/14/85	F	N	22.2	106.9	64.3	75%	2400	-	-	2400	33	-	-
4	5/12/85	F	N	23.7	110.0	64.0	85%	3500	400	100	4000	-	-	-
5	5/14/85	M	N	16.7	93.5	60.5	82%	1200	80	50	1330	-	-	-
9	5/17/85	M	N	23.2	110.0	51.5	83%	4300	37	-	4337	49	-	-
6	5/14/85	F	Y	45.7	143.5	75.5	67%	590	34	50	674	5	-	-
26	3/13/85	F	Y	42.7	135.0	75.0	100%	620	-	-	620	-	-	-
27	3/13/85	F	Y	43.7	135.0	75.5	84%	530	-	-	530	-	-	-
24	3/13/85	M	Y	46.7	134.5	75.5	70%	7500	600	1000	9100	-	-	200

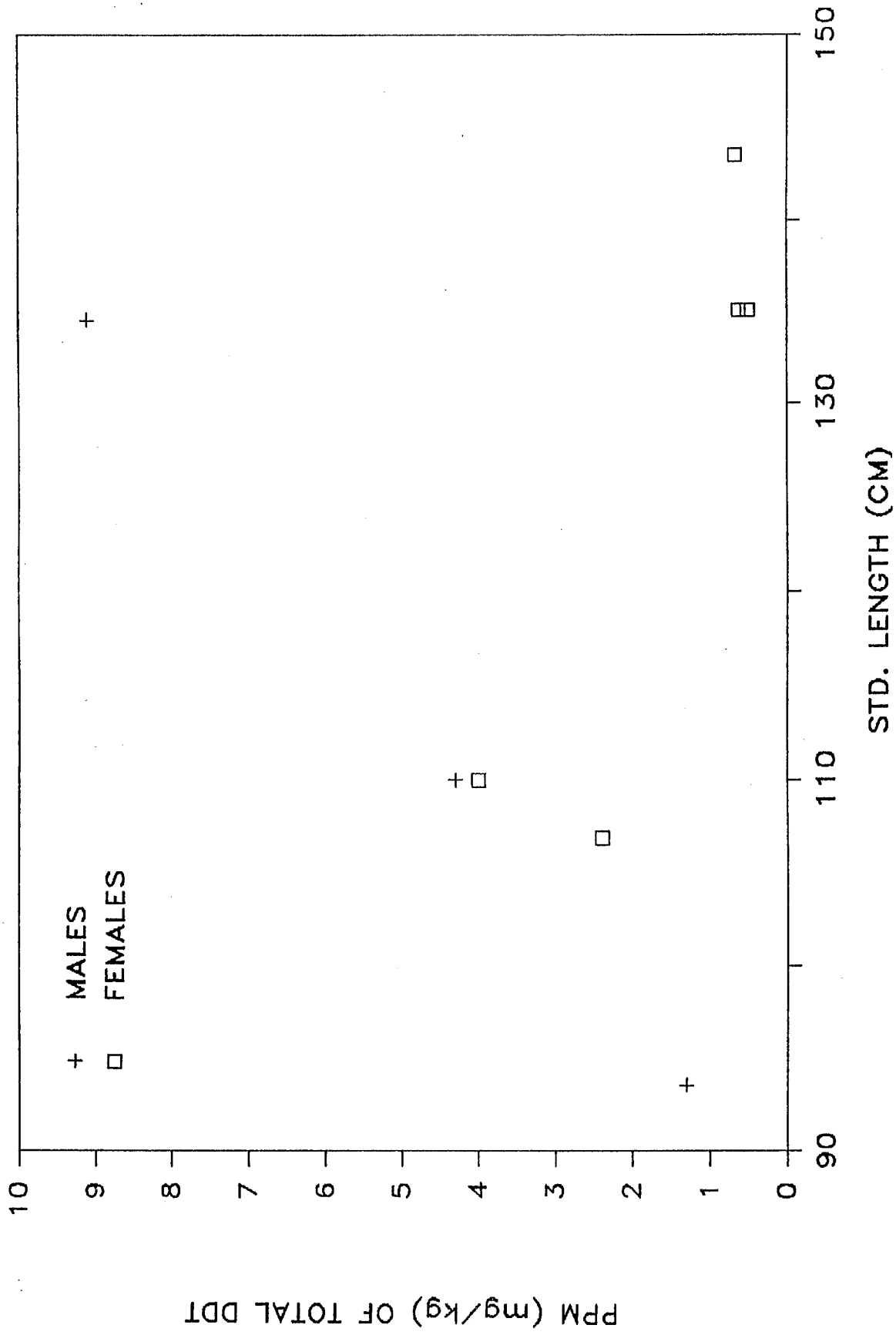


Figure 1. Concentration of total DDT in the blubber of male and female vaquita in relation to body length.

Table 2. Total DDT concentrations in harbor porpoise blubber. See footnotes at end of table for explanation of symbols and abbreviations.

Location	Year	Age	Sex	Wt	N	Concentration, ppm		Reference
						Mean	High	
Netherlands	78	F	U	L	1	6.7	-	Duinker and Hillebrand 1979
Rhode Is	73	A	F	W	1	57.5	-	Taruski et al 1975
Canada Atlantic	70	A	M	W	12	306.7	150.8 520.0	Gaskin et al 1971
Canada Atlantic	70	N	M	W	2	130.9	75.1 186.7	Gaskin et al 1971
Canada Atlantic	70	N	F	W	1	154.8	-	Gaskin et al 1971
Canada Atlantic	70	A	F	W	15	214.2	111.6 447.9	Gaskin et al 1971
Canada Atlantic	70	L	F	W	6	69.0	40.0 122.0	Gaskin et al 1971
Orkney, N Scotland	67	A	U	W	1	3.9	-	Holden and Marsden 1967
East Scotland, N Sea	66	A	U	W	3	43.0	27.9 55.3	Holden and Marsden 1967
North Sea	70	U	U	W	7	41.2	11.1 102.0	Koeman et al 1972
Baltic, German coast	76	U	B	W	2	37.6	29.3 45.9	Harms et al 1978
North Sea, Ger coast	76	U	F	W	1	2.4	-	Harms et al 1978
So. Calif. coast	75	S	F	W	1	335.0	-	O'Shea et al 1980
So. Calif. coast	75	S	F	W	1	2.3	-	O'Shea et al 1980
Coast of France	77	F	U	D	1	0.4	-	Alzieu and Duguy 1979
Coast of France	77	P	F	D	1	1.7	-	Alzieu and Duguy 1979

Table 2. Continued

Location	Year	Age	Sex	Wt	N	Concentration, ppm		Reference
						Mean	High	
Baltic Sea	72	U	B	L	8	171.0	30.0 289.0	Otterlind 1976
West coast, Sweden	74	U	U	L	6	160.0	24.8 560.0	Otterlind 1976
East coast, Denmark	75	U	U	L	4	8.1	2.2 12.0	Otterlind 1976
Baltic Sea	76			W	2	37.6	29.3 45.9	Huschenbeth 1977
Bay of Fundy	75	T	M	W	-	103.4	22.8 227.0	Gaskin et al. 1983
Bay of Fundy	75	T	F	W	-	39.3	21.4 55.7	Gaskin et al. 1983
Puget Sound	77	T	U	W	2	8.0	1.4 14.0	Calambokidis et al. 1984
California	85	T	B	W	16	46.0	6.2 132.	Calambokidis 1986
Oregon	85	T	B	W	13	19.0	2.1 52.1	Calambokidis 1986
Washington	85	T	B	W	7	13.0	0.2 26.4	Calambokidis 1986

Year: Collection year, midpoint if samples were collected over several years.

Age: A = adults
 S = subadults
 N = pup
 T = all age classes mixed
 P = pregnant female
 F = fetus
 U = unknown

Sex: F = female
 M = male
 B = mixed sexes
 U = unknown

Wt: weight basis for concentration, L = lipid weight, W = wet weight, D = dry weight

Table 3. PCB concentrations in harbor porpoise blubber. See footnotes at end of Table 2 for explanation of symbols and abbreviations.

Location	Year	Age	Sex	Wt	N	Concentration, ppm		Reference
						Mean	Low/High	
Netherlands	78	F	U	L	1	59.0	-	Duinker and Hillebrand 1979
Rhode Is	73	A	F	W	1	74.0	-	Taruski et al 1975
W coast Greenland	72	U	U	W	2	6.6	1.9 11.4	Clausen et al 1974
North Sea	70	U	U	W	7	88.0	35.0 148.0	Koeman et al 1972
Baltic, German coast	76	U	B	W	2	114.0	88.6 140.0	Harms et al 1978
So. Calif. coast	75	S	F	W	1	84.0	-	O'Shea et al 1980
So. Calif. coast	75	S	F	W	1	0.6	-	O'Shea et al 1980
Coast of France	77	T	U	D	2	3.8	1.4 6.1	Alzieu and Duguy 1979
Baltic Sea	72	U	B	L	8	93.4	28.0 190.0	Otterlind 1976
West coast, Sweden	74	U	U	L	6	159.0	56.4 260.0	Otterlind 1976
East coast, Denmark	75	U	U	L	4	142.0	68.0 210.0	Otterlind 1976
Baltic Sea	76			W	2	114.3	88.6 140.0	Huschenbeth 1977
Bay of Fundy	71	T	M	W	62	78.7	0.0 0.0	Gaskin et al. 1983
Bay of Fundy	71	T	F	W	40	46.6	0.0 0.0	Gaskin et al. 1983
Puget Sound	77	T	U	W	2	28.0	1.7 55.0	CaLambokidis et al. 1984
California	85	T	B	W	16	14.0	2.5 42.0	CaLambokidis 1986
Oregon	85	T	B	W	13	11.0	1.4 49.6	CaLambokidis 1986
Washington	85	T	B	W	7	17.0	0.2 29.8	CaLambokidis 1986

reported in the blubber of harbor porpoise from different parts of the world. Concentrations found in the vaquita are generally much lower than reported for harbor porpoise for most regions examined to date. In dramatic contrast to the vaquita are the concentrations of up to 2,000 ppm found in the blubber of coastal bottlenose dolphins from southern California (Schafer et al. 1984).

Aguilar (1984) concludes that the DDE / total DDT ratio in marine mammal tissues is indicative of the length of time DDT has been in the biota with .6 as the likely equilibrium ratio after a long period of degradation. The ratios found in this study are generally greater than .6 and indicate that the DDT input into this area is not recent. Borrell and Aguilar (1987) report a high percent DDE may also be the result of high overall contamination with DDT, but is clearly not the case for the vaquita.

Both DDE and PCBs have been linked to reproductive problems in marine mammals (Gilmartin et al. 1976, Reijnders 1982a, 1982b, 1986, Helle et al. 1976a, 1976b, Helle 1980). These problems have all been noted in species with accumulations of PCB and DDT products several orders of magnitude higher than found in the vaquita. Chlorinated hydrocarbon pesticides and PCBs do not appear to pose a threat to the small number of remaining vaquitas.

CONCLUSIONS

- Relatively low concentrations of DDT compounds, alpha-BHC, and PCBs were recovered from the tissues of 8 vaquita. DDT compounds occurred in the highest concentrations and the DDT metabolite DDE was the only compound recovered from all animals.
- Concentrations of DDT compounds suggested an accumulation with age in males and a declining concentration in females after reproductive maturity. This is consistent with findings in other studies of marine mammals.
- The proportion of DDE to total DDT suggest that the source of the DDT compounds is not from recent applications of DDT.
- Chlorinated hydrocarbon pesticides or PCBs do not appear to pose a hazard to the remaining vaquita.

ACKNOWLEDGMENTS

This research would not have been possible without the help of a number of people and organizations. A number of people helped collect and provide the tissues for analysis including: R.L. Brownell, L.T. Findley, O. Vidal, A. Robles, S. Manzanilla, and J. Barlow. Analytical Resources Inc. conducted the laboratory analysis of the samples with D.R. Mitchell coordinating this effort. The Marine Mammal Commission provided funding for the analysis. G.H. Steiger and J.C. Cabbage reviewed the report.

REFERENCES

- Addison, R.F., S.R. Kerr, J. Dale, and D.E. Sergeant. 1973. Variation of organochlorine residue levels with age in Gulf of St. Lawrence harp seals (Pagophilus groenlandicus). J. Fish. Res. Board Can. 30:595-600.
- Addison, R.F. and T.G. Smith. 1974. Organochlorine residue levels in Arctic ringed seals: variation with age and sex. Oikos 25:335-337.
- Aguilar, A. 1984. Relationship of DDE/TDDT in marine mammals to the chronology of DDT input into the ecosystem. Can. J. Fish. Aquat. Sci. 41:840-844.
- Alzieu, C. and R. Duguy. 1979. Organochlorine compound levels in cetaceans and pinnipeds living along the French coasts. Oceanol. Acta. 2:107-120.
- Alzieu, C., R. Duguy, and P. Babin. 1982. Etude des mammiferes marins comme detecteurs de pollutions. Unpublished report in French. C.N.E.X.O. Contract No. 81/2448.
- Andersen, S.H. and A. Rebsdorff. 1976. Polychlorinated hydrocarbons and heavy metals in harbour porpoise (Phocoena phocoena) and whitebeaked dolphin (Lagenorhynchus albirostris) from Danish waters. Aquat. Mamm. 4:14-20.
- Borrell, A. and A. Aguilar. 1987. Variations in DDE percentage correlated with total DDT burden in the blubber of fin and sei whales. Mar. Pollut. Bull. 18:70-74.
- Brownell, R.L., Jr. 1983. Phocoena sinus. Mammal. Spec. 217:1-4.
- Brownell, R.L., Jr. 1986. Distribution of the vaquita, Phocoena sinus, in Mexican waters. Mar. Mamm. Sci. 2:299-305.
- Brownell, R.L., Jr., L.T. Findley, O. Vidal, A. Robles, and S. Manzanilla. 1987. External morphology and pigmentation of the vaquita, Phocoena sinus (Cetacea: Mammalia), Mar. Mamm. Sci. 3:22-30.
- Calambokidis, J., J. Peard, G.H. Steiger, J.C. Cabbage, and R.L. DeLong. 1984. Chemical contaminants in marine mammals from Washington State. NOAA Tech. Mem. NOS OMS 6, Rockville MD. 167 pp.

- Calambokidis, J. 1986. Chlorinated hydrocarbons in harbor porpoise from Washington, Oregon, and California: Regional differences in pollutant ratios. SW Fish. Cent. Adm. Rep. LJ-86-35C. 29 pp.
- Clausen, J., L. Braestrup, and O. Berg. 1974. The content of polychlorinated hydrocarbons in Arctic mammals. Bull. Environ. Contam. Toxicol. 11:529-534.
- Donkin, P., S.V. Mann, and E.I. Hamilton. 1981. Polychlorinated biphenyl, DDT, and dieldrin residues in grey seal (Halichoerus grypus) males, females, and mother-foetus pairs sampled at the Farne Islands, England, during the breeding season. Sci. Total Environ. 19:121-142.
- Duinker, J.C. and M.Th.J. Hillebrand. 1979. Mobilization of organochlorines from female lipid tissue and transplacental transfer to fetus in a harbor porpoise (Phocoena phocoena) in a contaminated area. Bull. Environ. Contam. Toxicol. 23:728-732.
- Gaskin, D.E., R. Frank, and M. Holdrinet. 1983. Polychlorinated biphenyls in harbor porpoises Phocoena phocoena (L.) from the Bay of Fundy, Canada and adjacent waters, with some information on chlordanes and hexachlorobenzene levels. Arch. Environ. Contam. Toxicol. 12: 211-219.
- Gaskin, D.E., M. Holdrinet, and R. Frank. 1971. Organochlorine pesticide residues in harbour porpoises from the Bay of Fundy region. Nature (Lond.) 233:499-500.
- Gaskin, D.E., M. Holdrinet, and R. Frank. 1982. DDT residues in blubber of harbour porpoise, Phocoena phocoena (L.) from eastern Canadian waters during the five-year period 1969-1973. Mammals in the Seas, FAO Fish. Ser. No. 5, 4:135-143.
- Gaskin, D.E., G.J.D. Smith, P.W. Arnold, M.V. Louisy, R. Frank, M. Holdrinet, and J.W. McWade. 1974. Mercury, DDT, dieldrin, and PCB in two species of Odontoceti (Cetacea) from St. Lucia, Lesser Antilles. J. Fish. Res. Board Can. 31:1235-1239.
- Gilmartin, W.G., R.L. DeLong, A.W. Smith, J.C. Sweeney, B.W. DeLappe, R.W. Risebrough, L.A. Griner, M.D. Dailey, and D.B. Peakall. 1976. Premature parturition in the California sea lion. J. Wildl. Dis. 12:104-115.

- Harms, U., H.E. Drescher, and E. Huschenbeth. 1978. Further data on heavy metals and organochlorines in marine mammals from German coastal waters. *Meeresforsch* 26:153-161.
- Helle, E. 1980. Lowered reproductive capacity in female ringed seals (*Pusa hispida*) in the Bothnian Bay, northern Baltic Sea, with special reference to uterine occlusions. *Ann. Zool. Fenn.* 17:147-158.
- Helle, E., M. Olsson, and S. Jensen. 1976a. DDT and PCB levels and reproduction in ringed seal from the Bothnian Bay. *Ambio* 5:188-189.
- Helle, E., M. Olsson, and S. Jensen. 1976b. PCB levels correlated with pathological changes in seal uteri. *Ambio* 5:261-263.
- Holden, A.V. and K. Marsden. 1967. Organochlorine pesticides in seals and porpoises. *Nature (Lond.)* 216:1274-1276.
- Huschenbeth, E. 1977. Ergebnisse Über Schwermetall und Organohalogenuntersuchungen an verschiedenen Zahnwalen von der Ost und Nordseeküste Schleswig-Holsteins. *Inf. Fischwirtsch.* 24:162-164
- Koeman, J.H., W.H.M. Peters, C.J. Smith, P.S. Tjioe, and J.J.M. de Goeij. 1972. Persistent chemicals in marine mammals. *TNO Nieuws* 27:570-578.
- Matta, M.B., A.J. Mearns, and M.F. Buchman. 1986. Trends in DDT and PCBs in U.S. west coast fish and invertebrates. NOAA, Seattle, WA. 95 pp.
- O'Shea, T.J., R.L. Brownell, Jr., D.R. Clark, Jr., W.A. Walker, M.L. Gay, and T.G. Lamont. 1980. Organochlorine pollutants in small cetaceans from the Pacific and South Atlantic Oceans, November 1968-June 1976. *Pest. Monit. J.* 14:35-46.
- Otterlind, G. 1976. The harbour porpoise (*Phocoena phocoena*) endangered in Swedish waters. *ICES C.M.* 1976/N:16.
- Reijnders, P.J.H. 1982a. Threats to the harbour seal population in the Wadden Sea. *MARINE MAMMALS OF THE WADDEN SEA*. P.J.H. Reijnders and W.J. Wolf, (eds.). Final report of the section 'Marine Mammals' of the Wadden Sea Working Group. Report 7. pp. 38-47.

- Reijnders, P.J.H. 1982b. On the ecology of the harbour seal Phoca vitulina in the Wadden Sea: population dynamics, residue levels, and management. *Vet. Quar.* 4:36-42.
- Reijnders, P.J.H. 1986. Reproductive failure in common seals feeding on fish from polluted coastal waters. *Nature (Lond.)* 324:456-457.
- Risebrough, R.W. 1978. Pollutants in marine mammals, a literature review and recommendations for research. Marine Mammal Commission, NTIS PB-290728, Wash. D.C. 64 pp.
- Schafer, H.A., R.W. Gossett, C.F. Ward, and A.M. Westcott. 1984. Chlorinated hydrocarbons in marine mammals. In: Southern California Coastal Water Research Project. Biennial Report, 1983-1984. Edited by W. Bascom. S. Calif. Coastal Water Res. Proj., Long Beach, CA.
- Taruski, A.G., C.E. Olney, and H.E. Winn. 1975. Chlorinated hydrocarbons in cetaceans. *J. Fish. Res. Board Can.* 32:2205-2209.
- Wagemann, R. and D.C.G. Muir. 1984. Concentrations of heavy metals and organochlorines in marine mammals of northern waters: Overview and evaluation. *Can. Tech. Rept. of Fish. and Aquat. Sci.* No. 1279. 95pp.

APPENDIX

INDIVIDUAL TEST RESULTS PROVIDED BY ANALYTICAL RESOURCES, INC.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - Method 608

Sample No: Method Blank

Lab Sample ID: 1421 MB
Matrix: Tissue
VTSR: 3/18/88

Date Extracted: 03/21/88
Date Analyzed: 04/09/88
Conc/Dil Factor: 1:2
Amount Extracted: NA

QC Report No.: 1421-Cascadia RC

GPC Cleanup: YES
Alumina Cleanup: YES

Data Release Authorized: Peter M. Kuylen

CAS Number		mg/Kg
319-84-6	Alpha-BHC	0.001 U
319-85-7	Beta-BHC	0.001 U
319-86-8	Delta-BHC	0.001 U
58-89-9	Gamma-BHC (Lindane)	0.001 U
76-44-8	Heptachlor	0.001 U
309-00-2	Aldrin	0.001 U
1024-57-3	Heptachlor Epoxide	0.001 U
959-98-8	Endosulfan I	0.001 U
60-57-1	Dieldrin	0.002 U
72-55-9	4,4'-DDE	0.002 U
72-20-8	Endrin	0.002 U
33212-65-9	Endosulfan II	0.002 U
72-54-8	4,4'-DDD	0.002 U
1031-07-8	Endosulfan Sulfate	0.002 U
50-29-3	4,4'-DDT	0.002 U
72-43-5	Methoxychlor	0.002 U
53494-70-5	Endrin Ketone	0.002 U
57-74-9	Chlordane	0.004 U
8001-35-2	Toxaphene	0.2 U
12674-11-2	Aroclor-1016	0.02 U
53469-21-9	Aroclor-1242	0.02 U
12672-29-6	Aroclor-1248	0.02 U
11097-69-1	Aroclor-1254	0.02 U
11096-82-5	Aroclor-1260	0.02 U

*** Pesticide Surrogate Recovery**

Dibutylchlorodate	91%
--------------------------	------------

Data Qualifiers

- U Indicates compound was analyzed for but not detected at the given detection limit.
- NR Indicates not reported due to chromatographic interference and/or dilution.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - Method 608

**Sample No: ITESM-MM-
850512-01-4-A**

QC Report No.: 1421-Cascadia RC

Lab Sample ID: 1421 A
Matrix: Tissue
VTSR: 3/18/88

Date Extracted: 03/21/88
Date Analyzed: 04/09/88
Conc/Dil Factor: 1:19
Amount Extracted: 30.39

GPC Cleanup: YES
Alumina Cleanup: YES

Data Release Authorized: Pete Mc Lyler

CAS Number		mg/Kg
319-84-6	Alpha-BHC	0.01 U
319-85-7	Beta-BHC	0.01 U
319-86-8	Delta-BHC	0.01 U
58-89-9	Gamma-BHC (Lindane)	0.01 U
76-44-8	Heptachlor	0.01 U
309-00-2	Aldrin	0.01 U
1024-57-3	Heptachlor Epoxide	0.01 U
959-98-8	Endosulfan I	0.01 U
60-57-1	Dieldrin	0.02 U
72-55-9	4,4'-DDE	3.5
72-20-8	Endrin	0.02 U
33212-65-9	Endosulfan II	0.02 U
72-54-8	4,4'-DDD	0.4
1031-07-8	Endosulfan Sulfate	0.02 U
50-29-3	4,4'-DDT	0.1
72-43-5	Methoxychlor	0.02 U
53494-70-5	Endrin Ketone	0.02 U
57-74-9	Chlordane	0.04 U
8001-35-2	Toxaphene	2 U
12674-11-2	Aroclor-1016	0.2 U
53469-21-9	Aroclor-1242	0.2 U
12672-29-6	Aroclor-1248	0.2 U
11097-69-1	Aroclor-1254	0.2 U
11096-82-5	Aroclor-1260	0.2 U

*** Pesticide Surrogate Recovery**

Dibutylchlorodate	NR
--------------------------	-----------

Data Qualifiers

U Indicates compound was analyzed for but not detected at the given detection limit.

NR Indicates not reported due to chromatographic interference and/or dilution.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - Method 608

**Sample No: ITESM-MM-
850514-01-5-A**

QC Report No.: 1421-Cascadia RC

Lab Sample ID: 1421 B
Matrix: Tissue
VTSR: 3/18/88

Date Extracted: 03/21/88
Date Analyzed: 04/09/88
Conc/Dil Factor: 1:25
Amount Extracted: 30.91

GPC Cleanup: YES
Alumina Cleanup: YES

Data Release Authorized: Peter M. Taylor

CAS Number		mg/Kg
319-84-6	Alpha-BHC	0.02 U
319-85-7	Beta-BHC	0.02 U
319-86-8	Delta-BHC	0.02 U
58-89-9	Gamma-BHC (Lindane)	0.02 U
76-44-8	Heptachlor	0.02 U
309-00-2	Aldrin	0.02 U
1024-57-3	Heptachlor Epoxide	0.02 U
959-98-8	Endosulfan I	0.02 U
60-57-1	Dieldrin	0.04 U
72-55-9	4,4'-DDE	1.2
72-20-8	Endrin	0.04 U
33212-65-9	Endosulfan II	0.04 U
72-54-8	4,4'-DDD	0.08
1031-07-8	Endosulfan Sulfate	0.04 U
50-29-3	4,4'-DDT	0.05
72-43-5	Methoxychlor	0.04 U
53494-70-5	Endrin Ketone	0.04 U
57-74-9	Chlordane	0.08 U
8001-35-2	Toxaphene	4 U
12674-11-2	Aroclor-1016	0.4 U
53469-21-9	Aroclor-1242	0.4 U
12672-29-6	Aroclor-1248	0.4 U
11097-69-1	Aroclor-1254	0.4 U
11096-82-5	Aroclor-1260	0.4 U

*** Pesticide Surrogate Recovery**

Dibutylchloroendate	NR
----------------------------	-----------

Data Qualifiers

U Indicates compound was analyzed for but not detected at the given detection limit.

NR Indicates not reported due to chromatographic interference and/or dilution.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - Method 608

**Sample No: ITESM-MM-
850313-04-24-A**

Lab Sample ID: 1421 C
Matrix: Tissue
VTSR: 3/18/88

Date Extracted: 03/21/88
Date Analyzed: 04/09/88
Conc/Dil Factor: 1:19
Amount Extracted: 30.41

QC Report No.: 1421-Cascadia RC

GPC Cleanup: YES
Alumina Cleanup: YES

Data Release Authorized: Peter M. Kaplan

CAS Number		mg/Kg
319-84-6	Alpha-BHC	0.01 U
319-85-7	Beta-BHC	0.01 U
319-86-8	Delta-BHC	0.01 U
58-89-9	Gamma-BHC (Lindane)	0.01 U
76-44-8	Heptachlor	0.01 U
309-00-2	Aldrin	0.01 U
1024-57-3	Heptachlor Epoxide	0.01 U
959-98-8	Endosulfan I	0.01 U
60-57-1	Dieldrin	0.02 U
72-55-9	4,4'-DDE	7.5
72-20-8	Endrin	0.02 U
33212-65-9	Endosulfan II	0.02 U
72-54-8	4,4'-DDD	0.6
1031-07-8	Endosulfan Sulfate	0.02 U
50-29-3	4,4'-DDT	1.0
72-43-5	Methoxychlor	0.02 U
53494-70-5	Endrin Ketone	0.02 U
57-74-9	Chlordane	0.04 U
8001-35-2	Toxaphene	2 U
12674-11-2	Aroclor-1016	0.2 U
53469-21-9	Aroclor-1242	0.2 U
12672-29-6	Aroclor-1248	0.2 U
11097-69-1	Aroclor-1254	0.2 U
11096-82-5	Aroclor-1260	0.2

*** Pesticide Surrogate Recovery**

Dibutylchlorodate	NR
--------------------------	-----------

Data Qualifiers

- U Indicates compound was analyzed for but not detected at the given detection limit.
- NR Indicates not reported due to chromatographic interference and/or dilution.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - PESTICIDE/CPB

SAMPLE NO: Method Blank

Lab Sample ID: 1682 MB
Matrix: Tissue
VTSR: 06/27/88

Date Extracted: 06/29/88
Date Analyzed: 07/20/88
Conc/Dil Factor: 1:10
Wet Weight Analyzed: NA

QC Report No.: 1682-CRC
Project No.: Porpoise Blubber
GPC Cleanup: NO
Alumina Cleanup: YES

Data Release Authorized: Peter Kepler

CAS Number		ug/Kg
319-84-6	Alpha-BHC	1.0 U
319-85-7	Beta-BHC	1.0 U
319-86-8	Delta-BHC	1.0 U
58-89-9	Gamma-BHC (Lindane)	1.0 U
76-44-8	Heptachlor	1.0 U
309-00-2	Aldrin	1.0 U
1024-57-3	Heptachlor Epoxide	1.0 U
959-98-8	Endosulfan I	3.0 U
60-57-1	Dieldrin	2.0 U
72-55-9	4,4'-DDE	2.0 U
72-20-8	Endrin	2.0 U
33212-65-9	Endosulfan II	2.0 U
72-54-8	4,4'-DDD	2.0 U
1031-07-8	Endosulfan Sulfate	2.0 U
50-29-3	4,4'-DDT	2.0 U
72-43-5	Methoxychlor	4.0 U
53494-70-5	Endrin Ketone	2.0 U
57-74-9	Chlordane	10 U
8001-35-2	Toxaphene	100 U
12674-11-2	Aroclor-1016	20 U
53469-21-9	Aroclor-1242	20 U
12672-29-6	Aroclor-1248	20 U
11097-69-1	Aroclor-1254	20 U
11096-82-5	Aroclor-1260	20 U

*** Pesticide Surrogate Recovery**

Dibutylchloroendate	67%
----------------------------	------------

Data Qualifiers

- U Indicates compound was analyzed for but not detected at the given detection limit.
- J Indicates a hit below the calculated detection limit but considered real by the analyst.
- NR Indicates not reported due to chromatographic interference and/or dilution.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - PESTICIDE/CPB

SAMPLE NO: 850313-01-26

Lab Sample ID: 1682 A
Matrix: Tissue
VTSR: 06/27/88

Date Extracted: 06/29/88
Date Analyzed: 07/22/88
Conc/Dil Factor: 1:200
Wet Weight Analyzed: 30.51

QC Report No.: 1682-CRC
Project No.: Porpoise Blubber
GPC Cleanup: NO
Alumina Cleanup: YES

Data Release Authorized: *Peter Kuylen*

CAS Number		ug/Kg
319-84-6	Alpha-BHC	20 U
319-85-7	Beta-BHC	20 U
319-86-8	Delta-BHC	20 U
58-89-9	Gamma-BHC (Lindane)	20 U
76-44-8	Heptachlor	20 U
309-00-2	Aldrin	20 U
1024-57-3	Heptachlor Epoxide	20 U
959-98-8	Endosulfan I	60 U
60-57-1	Dieldrin	40 U
72-55-9	4,4'-DDE	620
72-20-8	Endrin	40 U
33212-65-9	Endosulfan II	40 U
72-54-8	4,4'-DDD	45 U
1031-07-8	Endosulfan Sulfate	40 U
50-29-3	4,4'-DDT	40 U
72-43-5	Methoxychlor	80 U
53494-70-5	Endrin Ketone	40 U
57-74-9	Chlordane	200 U
8001-35-2	Toxaphene	2000 U
12674-11-2	Aroclor-1016	400 U
53469-21-9	Aroclor-1242	400 U
12672-29-6	Aroclor-1248	400 U
11097-69-1	Aroclor-1254	400 U
11096-82-5	Aroclor-1260	400 U

*** Pesticide Surrogate Recovery**

Dibutylchloroendate	NR
----------------------------	-----------

Data Qualifiers

- U Indicates compound was analyzed for but not detected at the given detection limit.
- J Indicates a hit below the calculated detection limit but considered real by the analyst.
- NR Indicates not reported due to chromatographic interference and/or dilution.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - PESTICIDE/CPB

SAMPLE NO: 850313-02/27

Lab Sample ID: 1682 B
Matrix: Tissue
VTSR: 06/27/88

Date Extracted: 06/29/88
Date Analyzed: 07/22/88
Conc/Dil Factor: 1:200
Wet Weight Analyzed: 30.99

QC Report No.: 1682-CRC
Project No.: Porpoise Blubber
GPC Cleanup: NO
Alumina Cleanup: YES

Data Release Authorized: Peter Kepler

CAS Number		ug/Kg
319-84-6	Alpha-BHC	20 U
319-85-7	Beta-BHC	20 U
319-86-8	Delta-BHC	20 U
58-89-9	Gamma-BHC (Lindane)	20 U
76-44-8	Heptachlor	20 U
309-00-2	Aldrin	20 U
1024-57-3	Heptachlor Epoxide	20 U
959-98-8	Endosulfan I	60 U
60-57-1	Dieldrin	40 U
72-55-9	4,4'-DDE	530
72-20-8	Endrin	40 U
33212-65-9	Endosulfan II	40 U
72-54-8	4,4'-DDD	40 U
1031-07-8	Endosulfan Sulfate	40 U
50-29-3	4,4'-DDT	40 U
72-43-5	Methoxychlor	80 U
53494-70-5	Endrin Ketone	40 U
57-74-9	Chlordane	200 U
8001-35-2	Toxaphene	2000 U
12674-11-2	Aroclor-1016	400 U
53469-21-9	Aroclor-1242	400 U
12672-29-6	Aroclor-1248	400 U
11097-69-1	Aroclor-1254	400 U
11096-82-5	Aroclor-1260	400 U

*** Pesticide Surrogate Recovery**

Dibutylchlorodate	NR
--------------------------	-----------

Data Qualifiers

- U Indicates compound was analyzed for but not detected at the given detection limit.
- J Indicates a hit below the calculated detection limit but considered real by the analyst.
- NR Indicates not reported due to chromatographic interference and/or dilution.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - PESTICIDE/CPB

SAMPLE NO: 850314-01-03

Lab Sample ID: 1682 C
Matrix: Tissue
YTSR: 06/27/88

Date Extracted: 06/29/88
Date Analyzed: 07/22/88
Conc/Dil Factor: 1:200
Wet Weight Analyzed: 30.06

QC Report No.: 1682-CRC
Project No.: Porpoise Blubber
GPC Cleanup: NO
Alumina Cleanup: YES

Data Release Authorized: Peter Kepler

CAS Number		ug/Kg
319-84-6	Alpha-BHC	33
319-85-7	Beta-BHC	20 U
319-86-8	Delta-BHC	20 U
58-89-9	Gamma-BHC (Lindane)	20 U
76-44-8	Heptachlor	20 U
309-00-2	Aldrin	20 U
1024-57-3	Heptachlor Epoxide	20 U
959-98-8	Endosulfan I	60 U
60-57-1	Dieldrin	40 U
72-55-9	4,4'-DDE	2400
72-20-8	Endrin	40 U
33212-65-9	Endosulfan II	40 U
72-54-8	4,4'-DDD	40 U
1031-07-8	Endosulfan Sulfate	40 U
50-29-3	4,4'-DDT	40 U
72-43-5	Methoxychlor	80 U
53494-70-5	Endrin Ketone	40 U
57-74-9	Chlordane	200 U
8001-35-2	Toxaphene	2000 U
12674-11-2	Aroclor-1016	400 U
53469-21-9	Aroclor-1242	400 U
12672-29-6	Aroclor-1248	400 U
11097-69-1	Aroclor-1254	400 U
11096-82-5	Aroclor-1260	400 U

*** Pesticide Surrogate Recovery**

Dibutylchloroendate	NR
----------------------------	-----------

Data Qualifiers

- U Indicates compound was analyzed for but not detected at the given detection limit.
- J Indicates a hit below the calculated detection limit but considered real by the analyst.
- NR Indicates not reported due to chromatographic interference and/or dilution.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - PESTICIDE/CPB

SAMPLE NO: 850514-02-06

Lab Sample ID: 1682 D
Matrix: Tissue
YTSR: 06/27/88

Date Extracted: 06/29/88
Date Analyzed: 07/20/88
Conc/Dil Factor: 1:10
Wet Weight Analyzed: 17.72

QC Report No.: 1682-CRC
Project No.: Porpoise Blubber
GPC Cleanup: NO
Alumina Cleanup: YES

Data Release Authorized: Peter Kaplan

CAS Number		ug/Kg
319-84-6	Alpha-BHC	5.0
319-85-7	Beta-BHC	2.0 U
319-86-8	Delta-BHC	2.0 U
58-89-9	Gamma-BHC (Lindane)	2.0 U
76-44-8	Heptachlor	2.0 U
309-00-2	Aldrin	2.0 U
1024-57-3	Heptachlor Epoxide	2.0 U
959-98-8	Endosulfan I	6.0 U
60-57-1	Dieldrin	4.0 U
72-55-9	4,4'-DDE	590
72-20-8	Endrin	4.0 U
33212-65-9	Endosulfan II	4.0 U
72-54-8	4,4'-DDD	34
1031-07-8	Endosulfan Sulfate	4.0 U
50-29-3	4,4'-DDT	50
72-43-5	Methoxychlor	8.0 U
53494-70-5	Endrin Ketone	4.0 U
57-74-9	Chlordane	20 U
8001-35-2	Toxaphene	200 U
12674-11-2	Aroclor-1016	40 U
53469-21-9	Aroclor-1242	40 U
12672-29-6	Aroclor-1248	40 U
11097-69-1	Aroclor-1254	40 U
11096-82-5	Aroclor-1260	40 U

*** Pesticide Surrogate Recovery**

Dibutylchloroendate	67%
----------------------------	------------

Data Qualifiers

- U Indicates compound was analyzed for but not detected at the given detection limit.
- J Indicates a hit below the calculated detection limit but considered real by the analyst.
- NR Indicates not reported due to chromatographic interference and/or dilution.



**ANALYTICAL
RESOURCES
INCORPORATED**

Analytical
Chemists &
Consultants

333 Ninth Ave. North
Seattle, Wa 98109-5187
(206) 621-6490

ORGANICS ANALYSIS DATA SHEET - PESTICIDE/CPB

SAMPLE NO: 850517-01-9

Lab Sample ID: 1682 E
Matrix: Tissue
YTSR: 06/27/88

Date Extracted: 06/29/88
Date Analyzed: 07/22/88
Conc/Dil Factor: 1:200
Wet Weight Analyzed: 30.01

QC Report No.: 1682-CRC
Project No.: Porpoise Blubber
GPC Cleanup: NO
Alumina Cleanup: YES

Data Release Authorized: Peter Kepler

CAS Number		ug/Kg
319-84-6	Alpha-BHC	49
319-85-7	Beta-BHC	20 U
319-86-8	Delta-BHC	20 U
58-89-9	Gemma-BHC (Lindane)	20 U
76-44-8	Heptachlor	20 U
309-00-2	Aldrin	20 U
1024-57-3	Heptachlor Epoxide	20 U
959-98-8	Endosulfan I	60 U
60-57-1	Dieldrin	40 U
72-55-9	4,4'-DDE	4300
72-20-8	Endrin	40 U
33212-65-9	Endosulfan II	40 U
72-54-8	4,4'-DDD	37 J
1031-07-8	Endosulfan Sulfate	40 U
50-29-3	4,4'-DDT	120 U
72-43-5	Methoxychlor	80 U
53494-70-5	Endrin Ketone	40 U
57-74-9	Chlordane	200 U
8001-35-2	Toxaphene	2000 U
12674-11-2	Aroclor-1016	400 U
53469-21-9	Aroclor-1242	400 U
12672-29-6	Aroclor-1248	400 U
11097-69-1	Aroclor-1254	400 U
11096-82-5	Aroclor-1260	400 U

*** Pesticide Surrogate Recovery**

Dibutylchloroendate	NR
----------------------------	-----------

Data Qualifiers

- U Indicates compound was analyzed for but not detected at the given detection limit.
- J Indicates a hit below the calculated detection limit but considered real by the analyst.
- NR Indicates not reported due to chromatographic interference and/or dilution.

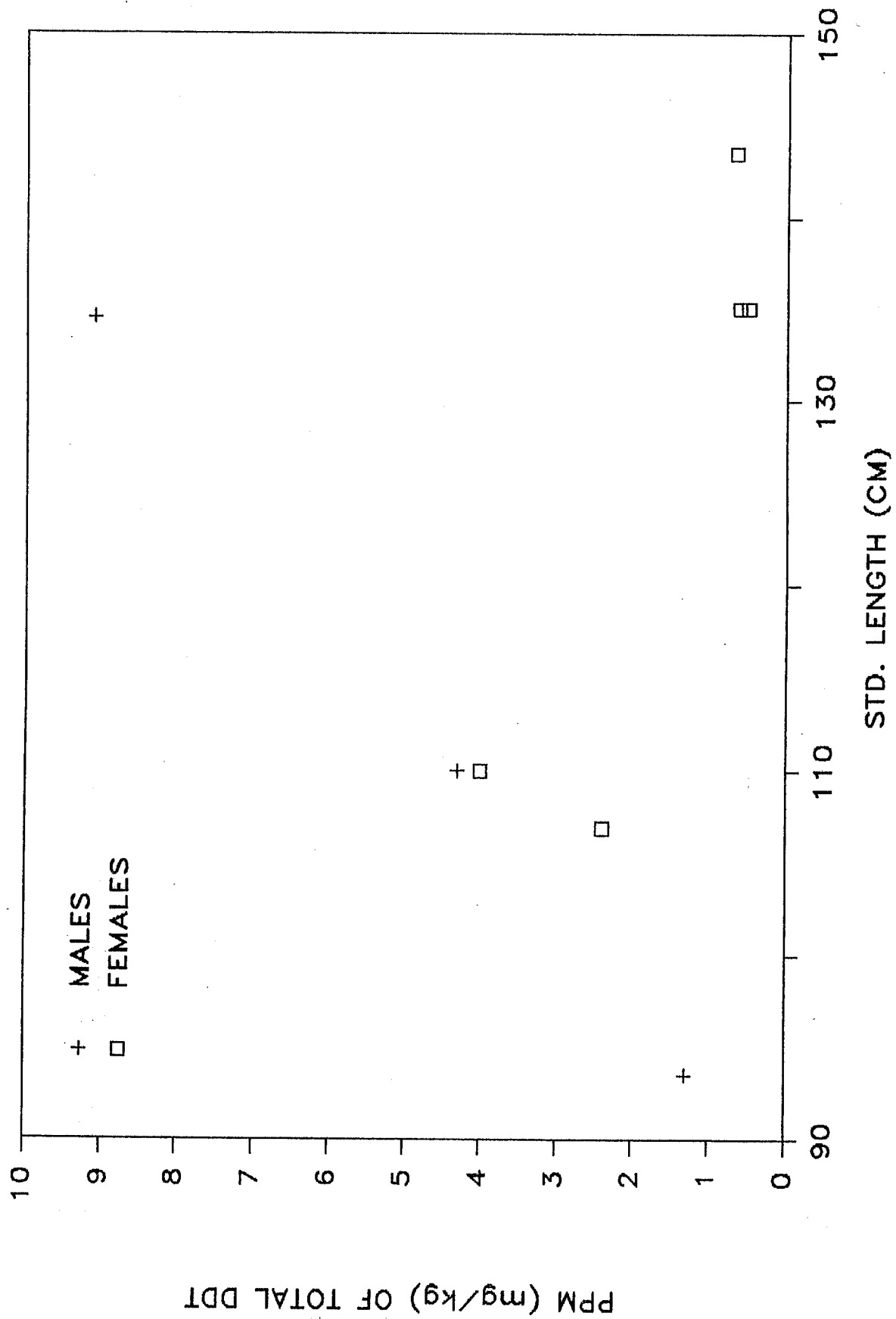


Figure 1. Concentration of total DDT in the blubber of male and female vaquita in relation to body length.