

*State of Alaska
Epidemiology*



Bulletin

*Recommendations
and
Reports*

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Assessment of Exposure to Persistent Organic Pollutants (POPs) in 5 Aleutian and Pribilof Villages

Final Report

(Amended as of 12/27/01)

FOREWORD

We presented the results of the “Assessment of Exposure to Persistent Organic Pollutants (POPS) in 5 Aleutian and Pribilof Villages” and published the findings (Epidemiology Bulletin Recommendations and Reports, Vol. 4 Number 1, May 4, 2000). When additional pesticide results became available, we published an Addendum to that original report (Addendum: Pesticide Results from St. Paul and St. George, Epidemiology Bulletin Recommendations and Reports, Vol. 4 Number 6, December 27, 2000).

Recently, the National Center for Environmental Health (NCEH), Centers for Disease Control and Prevention (CDC) notified us that a laboratory error had occurred. The results we reported in the above two Bulletins for the pesticides p,p'-DDE and p,p'-DDT were affected by that error. The NCEH laboratory informed us that all p,p'-DDE and p,p'-DDT values previously reported must be multiplied by a correction factor of 1.35. We have been assured by the NCEH that the results we originally presented for all other chemicals in this study were correct as reported.

The purpose of this report is to reissue the original Bulletin of May 4, 2000 after including all of the available data and making all relevant corrections to the DDE and DDT values. **This report replaces both the original Bulletin and the Addendum.**

Taking all data including pesticide corrections into account, our conclusions and recommendations remain the same. Especially for women of childbearing age, the low levels of POPs found strongly support current recommendations for continued unrestricted consumption of traditional foods. Changes or restrictions in the subsistence diet of villages are not recommended. Aleutian and Pribilof Islanders should continue to consume their subsistence foods, which are nutritious and provide many health and cultural benefits.

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INTRODUCTION

Pollution has long been recognized as a global problem. For decades, even in the Arctic, scientists have detected man-made pollutants throughout the environment. Winds and ocean currents carry man-made chemicals to the Arctic from the major industrial and agricultural areas in Europe, Asia, and North America. Other man-made chemicals, local in source, come from mining sites, military sites, garbage dumps, discarded batteries, motor oil, engine lubricants, antifreeze, and even cigarette smoke.

Persistent organic pollutants (POPs) are man-made chemicals such as polychlorinated biphenyls (PCBs), once widely used in industry but banned since 1977, and a range of pesticides, including DDT, lindane, chlordane, and mirex. In 1972, DDT, widely used in agricultural insect control throughout North America, was banned. Its use was discontinued in North America in 1973 except for public health emergencies. Its main use currently is for malaria control in developing countries. Lindane, chlordane, mirex, and several other pesticides were widely used in the 1960s and 1970s but were no longer in use in the U.S. by the end of the 1980s.

POPs do not break down (or break down very slowly) in the environment, so temperature, time, light, and bacteria don't change them much. POPs also do not break down when eaten by people or animals; instead they remain in the body. Furthermore, POPs do not dissolve in water but are fat soluble, meaning they are attracted to and collect in the fat of humans and animals. POPs, such as PCBs and certain pesticides, exist throughout the global environment. Therefore, almost everybody, people and animals, has measurable (although tiny) amounts of PCBs and pesticides in their fat and blood.

Very tiny amounts of POPs are present in many of the store-bought foods we commonly eat. They are also present in all of the world's food chains (on land, in the sea, and in freshwater). Concentrations in the Arctic are usually highest in the fat of marine mammals, especially killer whales, beluga whales, Stellar sea lions, and northern fur seal. Levels of POPs are not

uniformly distributed in all wildlife species or within all members of a specific species, and concentrations tend to rise with age.

Higher concentrations occur in older marine mammals for two reasons: they are older, and they are carnivorous. Because they are older, they have been consuming food longer and thus accumulating (bioaccumulating) POPs longer than younger members of the same species. Secondly, they eat other animals, and the animals they consume have POPs in them because they in turn have been eating other animals with POPs in their fat and blood. When a predator consumes another animal, the predator consumes the bioaccumulated POPs of its prey. As POPs move up the food chain, they increase in quantity at each step; this process is called biomagnification. Animals, such as sea lions, at the top of a long food chain are expected to have higher levels of POPs than animals at the end of a short food chain, such as caribou. Man is one of the animals at the top of one of the longer food chains.

BACKGROUND

For many years the indigenous people of the Arctic have expressed their concerns about the presence of man-made chemical pollutants and the possible adverse health effects from their accumulation and magnification in traditional food chains.

For over a decade the Alaska Division of Public Health (DPH) has been a partner with Alaska Native and non-Native populations in both rural and urban settings in investigating these environmental public health concerns. DPH, for instance, participated in the Arctic Monitoring and Assessment Program (AMAP), established by the eight circumpolar nations to monitor certain pollutants in the Arctic. In 1995 DPH joined with the International Whaling Commission and the International Walrus Commission in an Alaska Native workshop addressing environmental health concerns related to subsistence foods. In 1996, the DPH sponsored special sessions on arctic environmental contaminants and subsistence foods at the 10th International Congress on Circumpolar Health held in Anchorage. In 1998, DPH issued a report entitled "Use of Traditional

Foods in a Healthy Diet in Alaska: Risks in Perspective,” which examined the presence and health implications of heavy metals and POPs in subsistence foods. The report, which was developed with the assistance of many state and federal agencies, recommended the continued unrestricted consumption of traditional subsistence foods in Alaska. (The executive summary is available through the web site of the Section of Epidemiology at <http://www.epi.hss.state.ak.us/>)

Warnings from some marine biologists, chemists, news reporters, and others against eating marine mammals and fish generated new concerns about adverse health effects from traditional foods among some of the communities of the Aleutian and Pribilof Islands. Several tribal representatives and Alaska Native organizations, including the Aleutian/Pribilof Islands Association, requested DPH’s assistance in determining whether subsistence foods in the region are safe to eat.

In response, DPH’s Section of Epidemiology assessed exposure levels in volunteers in five Aleutian and Pribilof Island villages by drawing blood samples and having them analyzed by the Centers for Disease Control and Prevention (CDC).

While the assessment demonstrated that villagers in the Aleutian and Pribilof Islands have been exposed to POPs, we found nothing to cause us to change our recommendation to continue the unrestricted consumption of traditional foods in the region.

Methods

DPH’s Section of Epidemiology has been collaborating with Aleutian and Pribilof Islands villages and organizations in studying the possible health effects of POPs for many years. In 1998, DPH was awarded funds under a CDC request for proposals entitled “Building Environmental Health Response Capacity in Arctic Communities.” Early in 1999, CDC notified DPH that the federal agency would perform laboratory analysis for PCBs at no charge on approximately 200 samples.

Staff from Epidemiology contacted appropriate health care providers at the Alaska Native Health Services, Southcentral Foundation, the Alaska

Native Health Board, and the Aleutian/Pribilof Islands Association, Inc. Staff also contacted both tribal and village council members seeking both approval and guidance to implement the evaluation.

Between March and May, 1999, two nurses from the Section of Epidemiology visited five villages (St. Paul from March 4-8, St. George on March 12, Atka on May 4, Akutan on May 8-9, and Nikolski on May 11-12) where they recruited volunteers from village residents. They recruited mainly through door-to-door visits in the villages. They also held public clinics in St. Paul and St. George where villagers could come in, get their questions answered, and volunteer to have their blood drawn.

Since this activity was a public health assessment to determine if exposure had occurred and not a research project, we made no attempt to gather a random sample of bloods. We intended to sample the blood of those who may have been exposed to the highest levels of PCBs—older villagers who were lifetime consumers of subsistence foods and who, therefore, would have been most likely to have been exposed to PCBs. We did not refuse anyone 18 or older who sought testing. As a result, the ages of the volunteers ranged from 18 to 91 years.

The nurses drew blood from 168 volunteers from the five villages: 96 from St. Paul, 19 from St. George, 30 from Atka, 13 from Akutan, and 10 from Nikolski (Figure 1). The nurses noted the age and gender of each volunteer and conducted a very short interview getting limited subsistence information.

In addition to analyzing the blood samples for PCBs, the CDC lab also performed tests to detect the presence of several other chlorinated chemicals. Blood samples from the Aleutian villages were analyzed for several chlorinated pesticides, coplanar PCBs, furans, and dioxins. Later, at the request of the Tribal and Village

Councils of St. Paul and St. George, and the Aleutian/Pribilof Islands Association (APIA), the CDC analyzed pesticide levels in the blood specimens from St. Paul and St. George. The CDC was not able to analyze the blood samples from St. Paul and St. George for coplanar PCBs, furans, and dioxins because the amount of blood collected was too small.

Several pesticides were tested for and detected in some Aleutian and Pribilof volunteers, including β -hexachlorocyclohexane, heptachlor epoxide, oxychlorane, trans-nonachlor, p,p'-DDE, p,p'-DDT, dieldrin and mirex. Several other pesticides were tested for but not detected in any volunteers, including gamma-hexachlorocyclohexane (lindane), aldrin and o,p-DDT.

When we first drew blood from volunteers in St. Paul and St. George, we planned to test for PCBs. We did not know that CDC could or would analyze the blood samples for pesticides as well. Therefore, we did not request approval to measure pesticides from the volunteers. We did obtain approval to test for PCBs, pesticides, furans, and dioxins from volunteers in Atka, Akutan, and Nikolski.

As a result, our first report did not include any pesticide results from St. Paul and St. George volunteers. After we presented the results, the Tribal and Village Councils of St. Paul and St. George and the Aleutian/Pribilof Islands Association, Inc. (APIA) requested that we proceed with testing blood specimens from St. Paul and St. George for pesticides. These results were summarized in our second report (*Epidemiology Bulletin Recommendations and Reports*, Vol. 4 No. 6, December 27, 2000).

Construction problems adjacent to the CDC laboratory caused a delay in analyzing the samples. CDC reported the PCB results to the Section of Epidemiology on September 10, 1999 and the pesticide results from the Aleutian Island villages of Atka, Akutan, and Nikolski on October 1, 1999. CDC reported the PCB results to the Section of Epidemiology for St. Paul and St. George on November 23, 1999.

The data provided by CDC required a great deal of complex and prolonged analysis by the Section

of Epidemiology staff. For example, for the PCB results alone, 72 raw numbers were provided for each of over 180 samples analyzed. Similarly, 26 raw numbers were provided for pesticides and 44 raw numbers were provided for dioxin-like chemicals for each of over 50 samples analyzed. In all, a stack of computer printouts approximately six inches high was provided to the Section. Several months of labor were invested to compile and summarize the data carefully, and then to locate and study suitable comparison data from the literature with which to interpret the results.

Recently, the CDC laboratory notified us of an error that affected the results of the measurements of p,p'-DDE and p,p'-DDT. After receiving written notification of the lab error affecting the DDT and DDE values, the required additional calculations were performed and the data for those chemicals was re-analyzed. We have compiled all the results into this final, corrected report.

One question always asked by anybody who gets a blood test is, "How do my results compare to the norm?" The norm for exposure to POPs is usually set as a range, called a reference range. Reference range data differ among the different chemical compounds that make up the class of POPs. Thus the reference range for PCBs and DDT would not necessarily be the same. In addition, if we want to compare our results with other results, we must adjust our data to account for the differing degree of fasting among the volunteers before they had their blood drawn. Blood has more fat or lipid in it after a person eats, and PCBs collect in the fat. We collected no information from our volunteers regarding recent food consumption. Fortunately, the CDC lab can adjust the results for differences in lipid concentrations, and thus reduce the variability between blood drawn from fasting volunteers and those who consumed food before the blood draw.¹ We show results as either not lipid-adjusted or lipid-adjusted, in order to be able to compare our results to different studies.

¹ This process is referred to as "lipid-adjusting."

National reference range data, such as those discussed in this report for PCBs, are not available for most pesticides in human serum. The last large national study for such data occurred over twenty years ago, when analytical methodology was not adequate to measure pesticides at the very low levels that exist in human serum. Instead of comparing our results to these old data, we compared the pesticide results from the Aleutian villages to newer data from a group of high-consumption fish eaters from the Great Lakes area, a population in Arkansas with no apparent exposure, and a group of 131 Alaska Native women.

RESULTS

The CDC lab successfully analyzed the blood of 166 participants for PCBs and most pesticides. Due to analytical quality problems, trans-nonachlor values were not available for six of those participants, and mirex values were not available for four of those participants. Also, the CDC lab successfully analyzed the blood of 48 Aleutian participants for coplanar PCBs, furans and dioxins. Unfortunately, two of the blood samples from Akutan were damaged during shipment and could not be analyzed for any chemicals.

In order to test the accuracy of the lab, we submitted 10 “blind duplicates.” We drew two tubes of blood from 10 volunteers, and submitted each sample to CDC with different identification numbers. Comparisons of the results of these blind duplicates showed excellent analytic correlation by the CDC laboratory; that is, both samples from each volunteer tested the same.

PCBs

We were able to test blood from a total of 166 people from 5 villages. The median PCB level was 4.8 parts per billion (ppb); the lowest value was below detection and the highest was 53.7 ppb. The median lipid-adjusted PCB level was 643 ppb; the lowest value was below detection, and the highest value was 6,643 ppb (Table 1).

The median PCB levels were very similar for all five villages for both (non-adjusted) serum levels and lipid-adjusted serum levels (Table 1).

The most current reference range data for exposure to PCBs is 5 to 7 ppb. This represents the U.S. median PCB level (non-lipid-adjusted). Thus half the U.S. population would be above this level and half below. The median levels we found in the Aleutian and Pribilof Islands were quite similar to the national reference range.

Among the 166 persons sampled, 40 were women of childbearing age (between 15-44 years); their median non-lipid-adjusted PCB level was 2.0 ppb, with a range of 0-14.9 ppb (Table 1). PCB levels were strongly associated with age and were higher among older persons (Figures 2-3). In most age groups, median PCB levels were higher in men than women (Figure 4). Women of childbearing age (WCBA) had lower mean PCB levels than the overall group tested which included men and older persons (Figure 5).

We also compared our findings with an Arctic Monitoring and Assessment Program (AMAP) study of maternal blood PCB levels from other circumpolar countries. For the AMAP study, 6 circumpolar nations submitted blood samples from pregnant women to be tested for PCBs and 13 pesticides. The samples were collected in 1995-1996. We compared the same 14 PCB chemicals tested in the AMAP study with the 40 women of childbearing age in the 5 Aleutian/Pribilof Island villages. PCB levels in women of childbearing age from the five villages were similar to the levels found in the AMAP study (Table 2).

We also compared our results to findings of a recent analysis of POP exposure of Alaska Native women (Rubin, et.al.). This exposure analysis measured POPs in stored blood serum samples collected and banked in the mid-1980s from 131 women whose mean age at the time serum was collected was 57 years. The arithmetic mean level of total serum PCBs was 7.56 ppb, and the lipid-adjusted level was 1153 ppb. These PCB levels are similar to but slightly higher than those

we found; 7.69 ppb and the lipid-adjusted level 993 ppb (Table 3).

Exposure of Aleutian Island volunteers to dioxins, furans, and coplanar PCBs was lower than that of populations in the Lower 48. The mean level of overall dioxin toxic equivalents in the Aleutian volunteers was 17.1 parts per trillion (ppt) lipid-adjusted. This compares to a level of 56.8 ppt in a population from the Great Lakes area with high levels of fish consumption, and 22.2 ppt in a population from Arkansas with no known exposure (Table 4).

Pesticides

We obtained results from 166 Aleutian and Pribilof participants for several pesticides (Tables 5 and 6). Trans-nonachlor values were only available for 160 of those participants, and mirex values were obtained for 162 participants. Pesticide levels were very similar to those found among 131 Alaska Native women (Table 3).

Pesticide levels were highest for p,p'-DDE, with a median level of 7.54 ppb, and a range from below detection to 158 ppb. As with PCB levels, DDE levels were strongly associated with age and were higher among older persons (Figure 6). We obtained pesticide results from 40 women of childbearing age (WCBA). The median levels of pesticides were lower in women of childbearing age than in the overall group tested, and many pesticides were not detectable in a majority of WCBA (Table 7, Figures 7-14).

Levels of p,p'-DDE were higher in the Aleutian and Pribilof Islands women of childbearing age than in the maternal plasma from any of the other AMAP countries. Among the circumpolar countries, levels of trans-nonachlor and oxychlorane were highest in maternal plasma from Greenland and second highest in the Aleutian and Pribilof Islands women of childbearing age (Table 8).

We also compared the pesticide results from the Aleutian and Pribilof villages with Great Lakes fish eaters, a population in Arkansas with no known exposures, and Alaska Native women (Tables 3 and 9).

DISCUSSION

We found that persons in all 5 villages have been exposed to POPs at levels similar to those found in the U.S. population and in other arctic countries. While the assessment demonstrated that villagers in the Aleutian and Pribilof Islands have been exposed to POPs, we found nothing to cause us to change our recommendation to continue the unrestricted consumption of traditional foods in the region.

The POPs we measured are no longer in use in the United States. Long-term studies in the Great Lakes area have documented significant declines in the levels of PCBs and pesticides among the general population and among the fish-eating population during the past two decades. While similar data are not available for the Arctic, it is likely that similar trends can be expected in the Arctic in the future. By establishing programs to monitor levels of POPs in the local environment, in traditional foods, and in humans, we can obtain evidence to document whether levels do, indeed, decline in the future.

The levels we detected do not warrant recommending that any volunteer seek a medical exam or treatment, and do not warrant any restrictions on consumption of subsistence foods. We realize, however, that even in the absence of any demonstrated adverse health effects associated with exposure to POPs, individuals and communities may still have concerns about their exposures.

Risk assessment is of great value in regulating industrial wastes or in establishing site-specific clean-up levels. When assessing any risk associated with food consumption, however, it is important to consider benefits as well. Traditionally harvested foods have many benefits. As we stated in our "Use of Traditional Food in Alaska" report, "Traditional foods provide inexpensive and readily available nutrients, essential fatty acids, antioxidants, calories and protein, and many health benefits such as protection from diabetes, cardiovascular disease, improved maternal nutrition and neonatal and infant brain development." We also noted that the

traditional lifestyle and diet are also “of great importance to the self-definition, self-determination, cultural and socio-economic, and overall health and well-being of indigenous peoples.”

To address concerns about exposure to POPs, communities may wish to establish programs to monitor the levels of POPs in the local environment and in traditional foods and to conduct dietary surveys.

Although we have compared the PCB results of our evaluation to the median U.S. levels, our results cannot be used to describe the characteristics of the Aleutian and Pribilof Islands communities as a whole. There are two reasons for these limitations on our results.

First, the medical evaluation was not a research effort. We made no attempt to test the entire population nor to obtain a random sample of the population. In fact, we tried to encourage persons who most frequently consumed marine mammals and a traditional diet to participate in this assessment. Therefore, results cannot be generalized to the community at large. Secondly, different laboratories use different methods to measure POPs. Thus, we have difficulty comparing results which were obtained by using different methods.

Even with these two limitations in mind – a nonrandom sample and different lab methods—we compared our results with data from the AMAP study of maternal blood. We do not know how the women in the AMAP study were selected, how similar they are to the women involved in our evaluation in terms of age, parity, or breastfeeding history or even the relative accuracy of the analytical results from the two laboratories. Therefore, our results can not be directly compared.

We compared the same 14 PCB chemicals used in the AMAP study using only the results of the women of childbearing age who had volunteered to participate in our evaluation. PCB levels measured in the serum of the Aleutian/Pribilof

Islands volunteers are similar to those who participated in the AMAP study.

This evaluation does not tell us, however, whether the higher POP levels seen in older volunteers are due to recent exposures or not. Based on information about POP levels in other populations, it is likely that the source of POPs is global rather than local, and that most of the exposures occurred years ago when subsistence consumption levels may have been higher. Measuring PCB and pesticide levels over the next several years could provide evidence of the trends in PCB and pesticide levels in Alaska.

This exposure assessment cannot be used to evaluate potential local site-related exposures to POPs. Evaluation of local sites must be undertaken through separate efforts that can examine and characterize specific site-related exposures, risks, and standards for remediation and clean-up.

RECOMMENDATIONS AND CONCLUSIONS

This evaluation documents that exposures to PCBs and pesticides have occurred among residents of the Aleutian and Pribilof Islands.

Median PCB levels observed in the Aleutian and Pribilof Island villages during this evaluation were similar to the current U.S. median PCB levels of 5 to 7 ppb. The PCB and pesticide levels observed are not a cause for restricting consumption of subsistence foods. The levels we detected do not warrant any individual seeking a medical examination, test, or treatment.

Changes or restrictions in the subsistence diet of villages are not justified or recommended. Aleutian and Pribilof Islanders should continue to consume their subsistence foods, which are nutritious and provide many health and cultural benefits.

It would be of great value to have more information on POP exposure levels of Alaska Natives and traditional foods, including:

- **Additional POPs blood testing in villages in the Aleutian Chain.** This would provide more information about levels of POPs in the area of the Aleutian Islands.
- **Gathering information about POPs levels in women of childbearing age.** Measuring levels of POPs in mothers, infant cord blood, and breast milk would provide more valuable information about the potential exposure of mothers, babies, and children, which are of most concern.
- **Compiling information about the use of traditional foods.** This could provide information about whether or not exposures were higher in the past, or have remained the same. We support the sampling of wildlife and traditional foods to add to this knowledge base. Measuring levels of POPs in birds and marine mammals would be of value in determining potential human exposure and for monitoring trends.
- **Future blood testing over time.** Together with information on traditional food use, this would provide information on the trends of levels of contaminants in traditional foods.

These activities could add a lot of information to what is known about contaminants in traditional foods in the Aleutian and Pribilof Islands and in Alaska. They could also answer more questions that people may have about this issue. This knowledge could be very useful to Native and non-Native people of Alaska and the Arctic. These and any other public health investigations should only be carried out in the support of each village.

Only ongoing monitoring will provide evidence of trends and enable the community to have assurance that exposures are declining.

Table. 1 Total PCBs in Serum, Aleutian and Pribilof Islands, Alaska 1999.

A. Not Lipid Adjusted (ppb)

Village	Number Tested	Arithmetic Mean	Standard Deviation	PCB (ppb) Median Level	Lowest Level	Highest Level
Akutan	11	8.4	5.8	5.5	2.8	17.9
Atka	30	14.7	13.5	8.0	n.d.	53.7
Nikolski	10	6.0	3.6	5.7	0.9	12.7
St. George	19	7.1	7.0	6.6	n.d.	29.6
St. Paul	96	5.7	6.9	3.4	n.d.	42.3
WCBA*	40	2.9	3.5	2.0	n.d.	14.9
Total	166	7.7	8.9	4.8	n.d.	53.7

*Women of Childbearing Age (all 5 villages combined)
n.d. = not detected

B. Lipid Adjusted (ppb)

Village	Number Tested	Arithmetic Mean	Standard Deviation	PCB (ppb) Median Level	Lowest Level	Highest Level
Akutan	11	968	577	613	382	1972
Atka	30	2096	1932	1214	n.d.	6643
Nikolski	10	971	697	765	125	2491
St. George	19	918	804	745	n.d.	3315
St. Paul	96	669	704	421	n.d.	3480
WCBA*	40	393	417	279	n.d.	1566
Total	166	994	1158	643	n.d.	6643

*Women of Childbearing Age (all 5 villages combined)
n.d. = not detected

Total PCB levels are the sum of 36 congeners – 18, 28, 52, 49, 44, 74, 66, 101, 99, 87, 110, 118, 105, 151, 149, 146, 153, 138-158, 128, 167, 156, 157, 178, 187, 183, 177, 172, 180, 170, 189, 201, 196-203, 195, 194, 206, 209

Table 2. Comparison of WCBA¹ from the Aleutian and Pribilof Islands, Alaska 1999 (N=40) with AMAP* Maternal Plasma Study (geometric means, ppb lipid), Sum of 14 Congeners

	n	Sum PCB
Aleutian/Pribilof-WCBA	40	463
Canada	67	167
Greenland	117	571
Sweden	40	222
Norway	60	173
Iceland	40	230
Russia	51	231

¹WCBA = Women of Childbearing Age

*Arctic Monitoring and Assessment Program, 1994-1996

Table 3. Arithmetic Mean Serum Concentrations of Pesticides and Total PCBs (ppb)

Compound	Aleutian & Pribilof Volunteers (n=166)	Comparison Alaska Native Women (n=131)^a	Aleutian & Pribilof Volunteers lipid adjusted (n=166)	Comparison Alaska Native Women lipid adjusted (n=131)^a
Oxychlorane	0.662	0.56	84.4	85.97
Trans-nonachlor	1.63	0.96	207.	149.89
Dieldrin	0.044	0.26	5.25	38.31
p,p'-DDE	13.9	9.10	1740.	1395.74
Total PCBs	7.69	7.56	993.	1153.07

a:from Rubin CH et al. 2001, *Int. J. Circumpolar Health* 60:157-169.

Table 4. Mean Dioxin Toxic Equivalents (TEQs) in Serum, parts per trillion (ppt) Lipid Adjusted

	Great Lakes Fisheaters (n=31)^a	Comparison population (No known exposure) Jacksonville, Arkansas (n=70)^a	Aleutian volunteers (n=48)
Dioxin Total TEQ	27.5	15.5	4.9
Furan Total TEQ	11.9	4.9	4.3
Coplanar PCB Total TEQ	17.4	1.8	7.9
Overall Total TEQ	56.8	22.2	17.1

^a from Anderson et al. 1998, *Env. Health Perspect.* 106, 279-289.

Table 5. Pesticides in Serum, Aleutian and Pribilof Villages (n=166)

	Arithmetic Mean	Standard Deviation	Median Level	LOD Range ^a	Lowest Level	Highest Level	
A. Not Lipid Adjusted (ppb)							
b-HCCH (hexachlorocyclohexane)	0.353	0.461	0.194	0.080 - 1.98	n.d.	2.59	
Heptachlor Epoxide	0.114	0.208	n.d.	0.080 - 0.493	n.d.	1.62	
Oxychlorane	0.662	0.825	0.366	0.079 - 0.355	n.d.	4.23	
Trans-nonachlor	1.63	2.16	0.824	0.079 - 0.355	n.d.	12.4	n = 160
p,p'-DDE	13.9	18.0	7.54	0.152 - 0.446	n.d.	158.	
Dieldrin	0.044	0.088	n.d.	0.090 - 0.520	n.d.	0.531	
p,p'-DDT	0.047	0.114	n.d.	0.122 - 0.784	n.d.	0.578	
Mirex	0.097	0.154	n.d.	0.090 - 2.56	n.d.	0.795	n = 162
B. Lipid Adjusted (ppb)							
b-HCCH (hexachlorocyclohexane)	44.2	54.0	26.8	4.70 - 231	n.d.	264.	
Heptachlor epoxide	13.7	25.0	n.d.	4.70 - 66.6	n.d.	189.	
Oxychlorane	84.4	109.	50.2	4.70 - 66.6	n.d.	692.	
Trans-nonachlor	207.	273.	116.	4.70 - 66.6	n.d.	1780.	n = 160
pp-DDE	1740.	1870.	1050.	9.04 - 62.2	n.d.	11600.	
Dieldrin	5.25	11.0	n.d.	4.70 - 83.4	n.d.	65.0	
pp-DDT	6.05	15.5	n.d.	8.64 - 79.0	n.d.	99.8	
Mirex	12.5	21.6	n.d.	4.70 - 268	n.d.	165.	n = 162

a: LOD: Limits of Detection, which were both individual- and chemical-specific
n.d. = not detected

Table 6. Serum Concentrations of Pesticides and Total PCBs (ppb) by Village Arithmetic Mean with Median in Parentheses

n	Akutan 11	Atka 30	Nikolski 10	St. George 19	St. Paul 96	TOTAL 166
b-HCCH	0.351 (0.255)	0.529 (0.299)	0.239 (0.252)	0.385 (0.234)	0.304 (0.150)	0.353 (0.194)
Heptachlor Epoxide	0.145 (0.116)	0.187 (0.060)	0.061 (n.d.)	0.079 (n.d.)	0.099 (n.d.)	0.114 (n.d.)
Oxychlorane	0.842 (0.654)	1.30 (0.630)	0.387 (0.408)	0.585 (0.505)	0.486 (0.282)	0.662 (0.366)
Trans-nonachlor	1.26 (0.688)	3.20 (1.79)	0.795 (0.816)	1.26 (0.955)	1.33 (0.672)	1.63 (0.824)
p,p'-DDE	12.3 (9.72)	16.9 (9.78)	10.4 (11.3)	11.7 (7.84)	14.0 (6.46)	13.9 (7.54)
Dieldrin	0.044 (n.d.)	0.097 (n.d.)	0.012 (n.d.)	0.020 (n.d.)	0.036 (n.d.)	0.044 (n.d.)
p,p'-DDT	0.048 (n.d.)	0.148 (n.d.)	0.068 (n.d.)	0.014 (n.d.)	0.019 (n.d.)	0.047 (n.d.)
Mirex	0.038 (n.d.)	0.218 (0.177)	0.069 (n.d.)	0.121 (0.097)	0.062 (n.d.)	0.097 (n.d.)
Total PCBs	8.4 (5.5)	14.7 (8.0)	6.0 (5.7)	7.1 (6.6)	5.7 (3.4)	7.7 (4.8)

n.d. = not detected

Table 7. Serum Concentrations of Pesticides and Total PCBs (ppb) in Women of Childbearing Age (n=40)

	Arithmetic Mean	Median	# of WCBA Non-Detects	% of WCBA Non-Detects
b-HCCH	0.123	n.d.	21	53
Heptachlor Epoxide	0.022	n.d.	36	90
Oxychlorthane	0.263	0.175	14	35
Trans-nonachlor	0.619	0.321	8	20
p,p'-DDE	6.09	4.07	2	5
Dieldrin	0.011	n.d.	37	93
p,p'-DDT	0.026	n.d.	36	90
Mirex	0.021	n.d.	34	85
Total PCBs	2.9	2.0	10	25

n.d. = not detected

Table 8. Comparison with AMAP Maternal Plasma Study (geometric means, ppb lipid) Pesticides, Circumpolar Study 1994-1996

	Aleutian & Pribilof WCBA ^a n=40	Canada n=67	Greenland n=117	Sweden n=40	Norway n=60	Iceland n=40	Russia n=51
b-HCCH	24.7	9.3	18.5	9.2	8.1	32.1	222.5
p,p'-DDE	503.	133.	407.	84.	79.4	113.2	411.9
p,p'-DDT	b	7.9	15.	2.4	3.	4.	48.3
Mirex	c	4.5	9.1	1.1	1.4	1.9	1.4
Oxychlorthane	28.5	27.8	60.8	1.9	3.7	6.6	3.3
T-nonachlor	49.8	30.5	110.	3.8	6.8	12.2	11.5

a: Aleutian & Pribilof Women of Childbearing Age

b. Geometric mean not calculated because p,p'-DDT was not detected in 36 of 40 samples. Arithmetic mean was 2.79 ppb lipid.

c. Geometric mean not calculated because mirex was not detected in 34 of 40 samples. Arithmetic mean was 2.64 ppb lipid.

Table 9. Median Serum Concentrations of Pesticides (ppb)

Compound	Comparison Great Lakes Fish eaters (N=30)	Comparison Arkansas (n=180) ^a	Aleutian & Pribilof volunteers (n=166)
b-HCCH	0.05	n.d.	0.194
Heptachlor Epoxide	0.1	0.1	n.d.
Oxychlorane	0.3	0.2	0.366
Trans-nonachlor	0.6	0.2	0.824
Dieldrin	0.2	n.d.	n.d.
p,p'-DDE	5.2	2.8	7.54
p,p'-DDT	0.3	n.d.	n.d.

a: from Anderson et al. 1998, Env. Health Perspect. 106, 279-289.
n.d. = not detected

Figure 1. Aleutian and Pribilof Islands

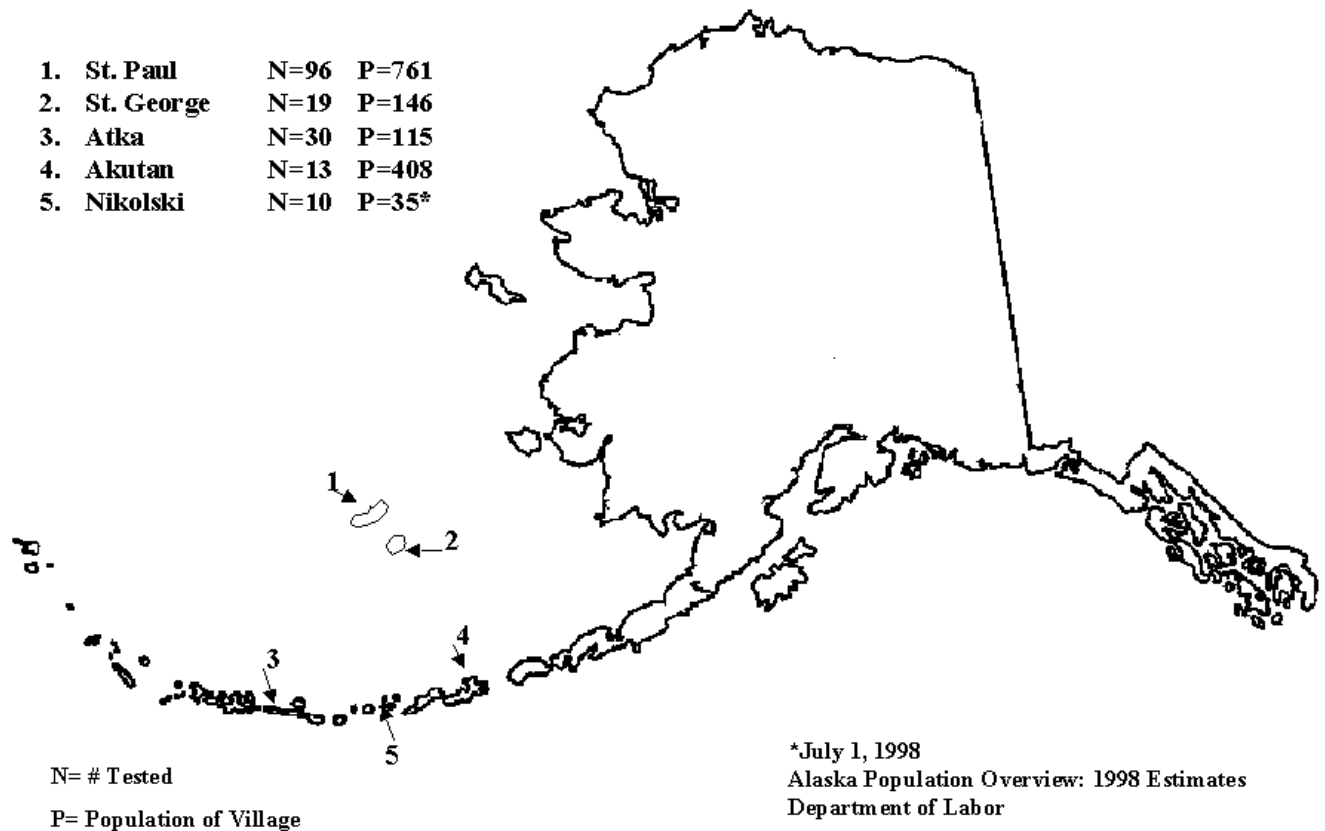


Figure 2. Total PCB serum levels (ppb) and Age
5 Aleutian and Pribilof Villages, Alaska 1999

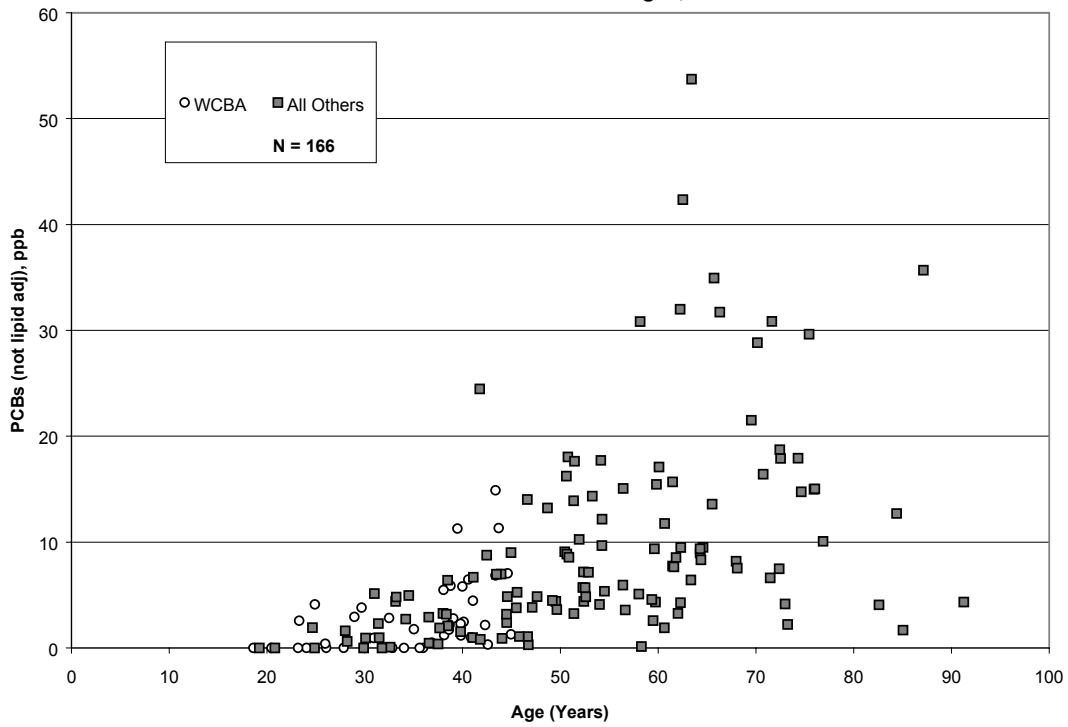


Figure 3. Lipid-adjusted Total PCB serum levels (ppb) and Age
5 Aleutian and Pribilof Villages, Alaska 1999

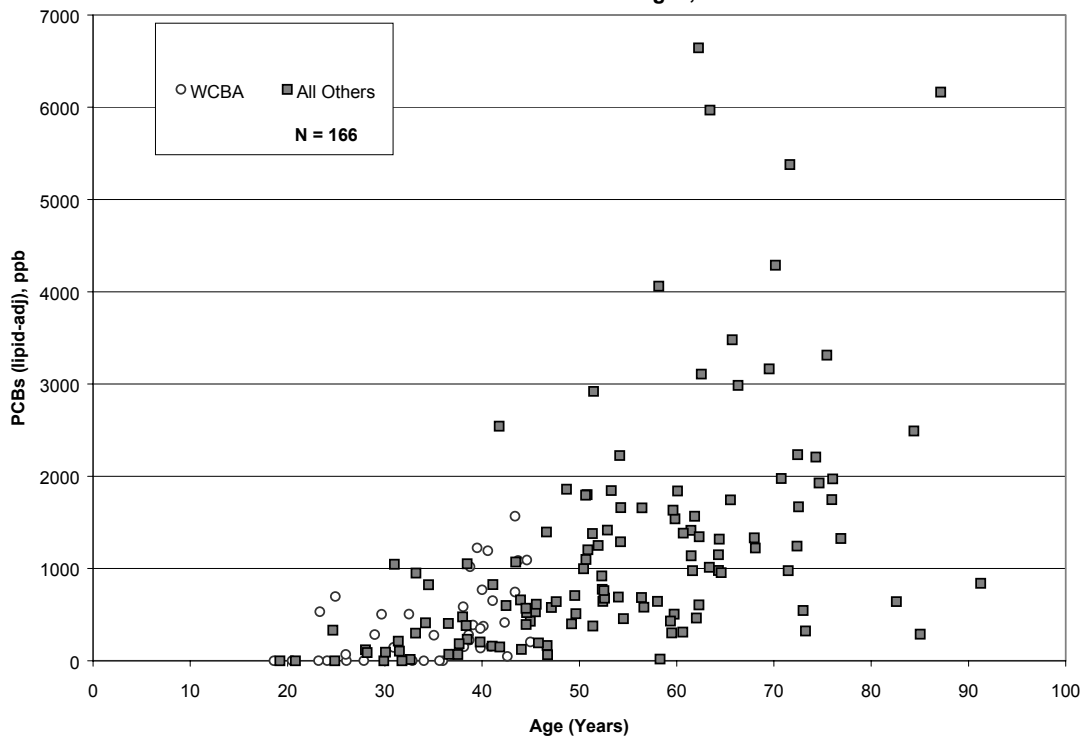


Figure 4. Median PCB levels by age and sex
Numbers above bars = n

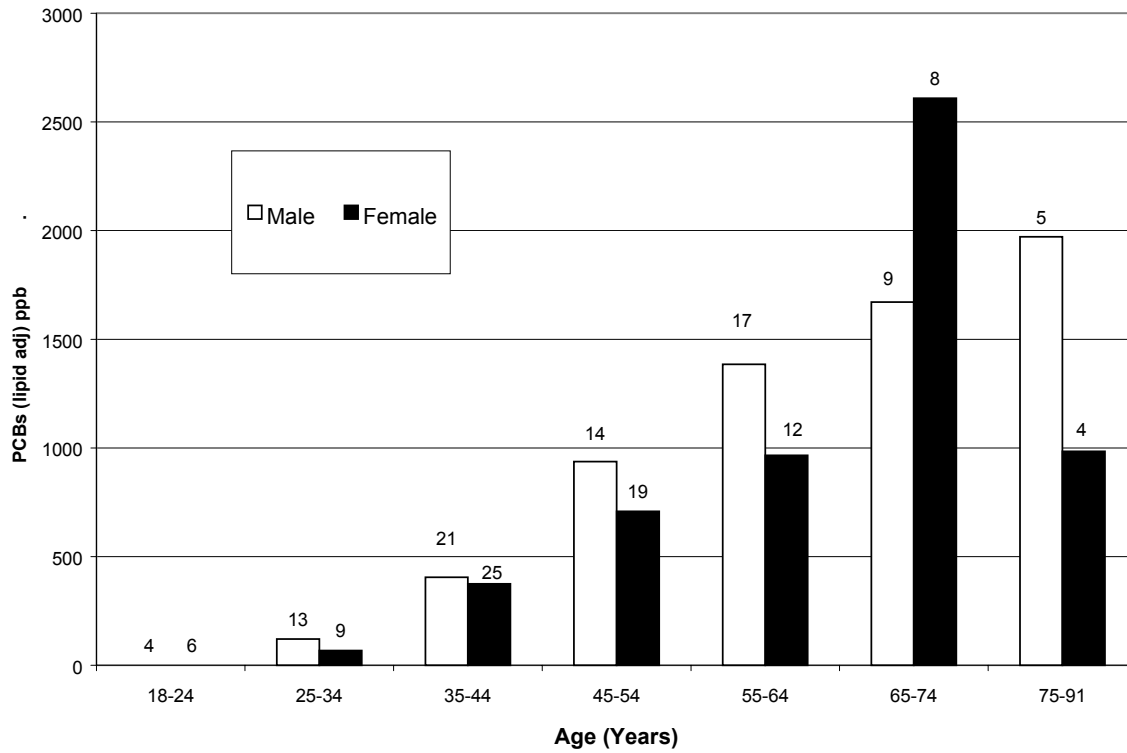
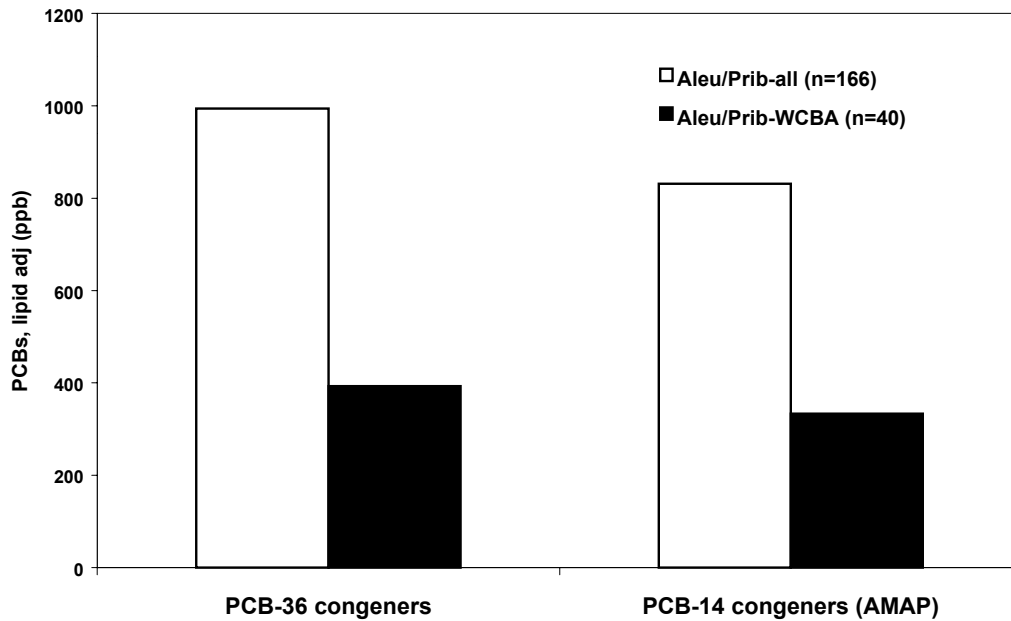


Figure 5. Lipid-adjusted PCB serum levels (ppb) aggregate data vs. WCBA only (arithmetic mean)



**Figure 6. Mean pesticide levels by age
5 Aleutian and Pribilof Villages, Alaska 1999
n=166**

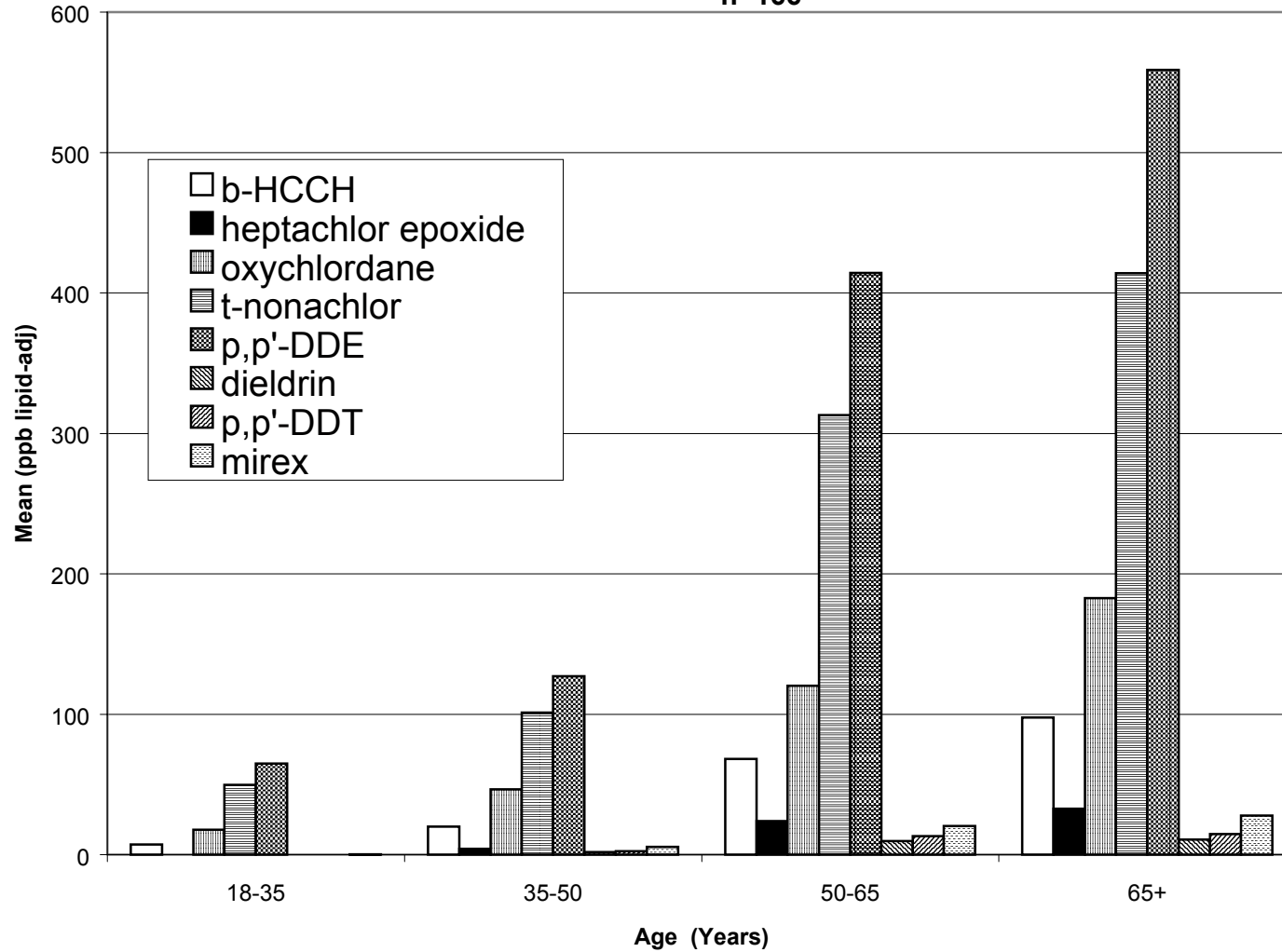


Figure 7. b-HCCH serum levels (ppb) and Age
5 Aleutian and Pribilof Villages, Alaska 1999

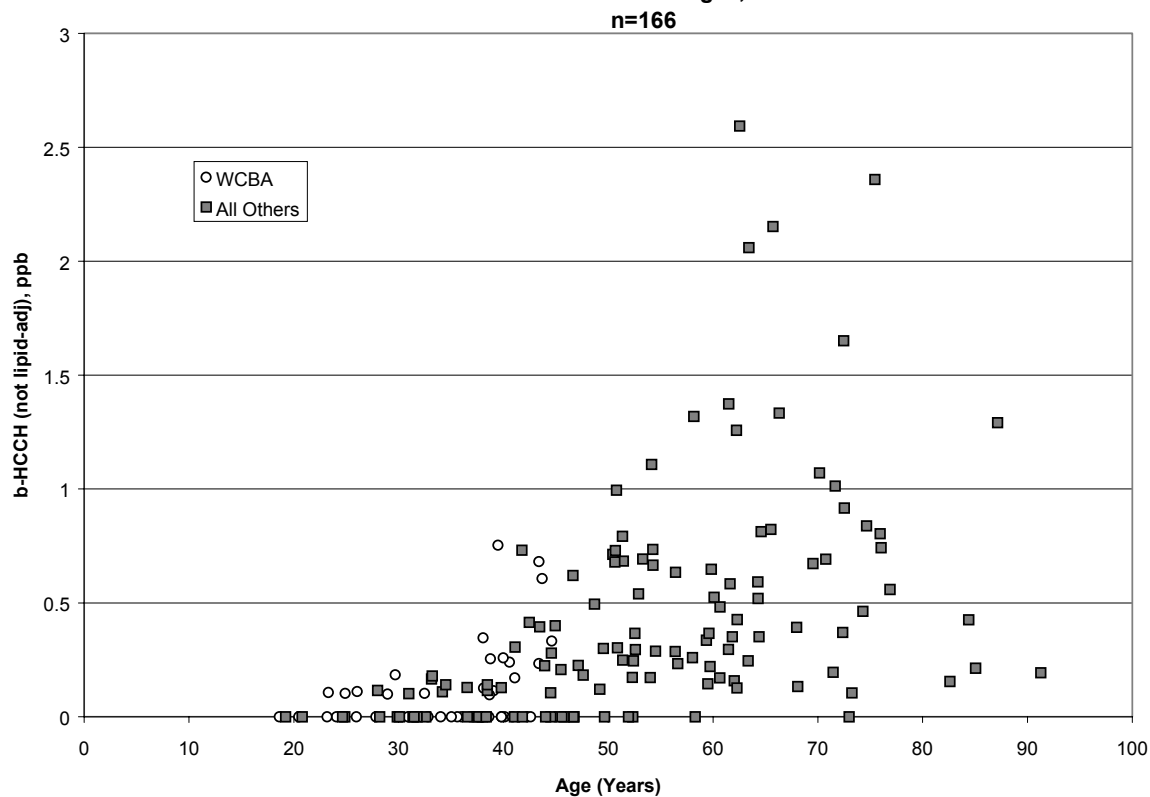


Figure 8. Heptachlor Epoxide serum levels (ppb) and Age
5 Aleutian and Pribilof Villages, Alaska 1999

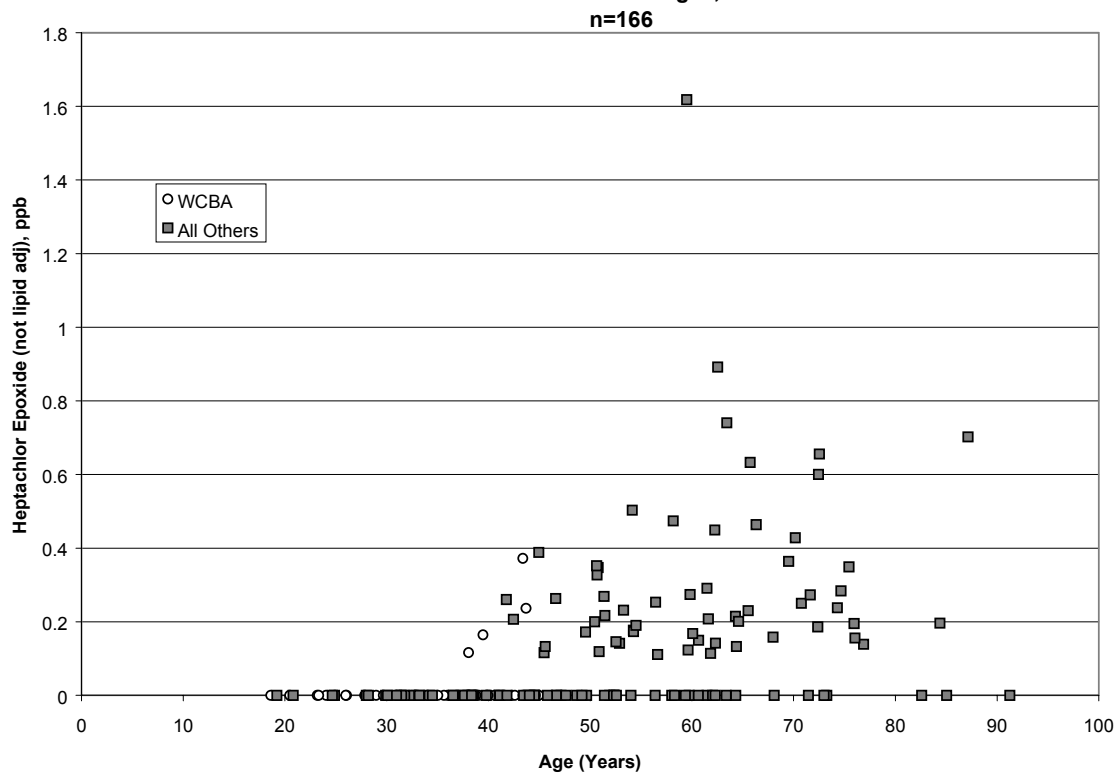


Figure 9. Oxychlordane serum levels (ppb) and Age
5 Aleutian and Pribilof Villages, Alaska 1999
n=166

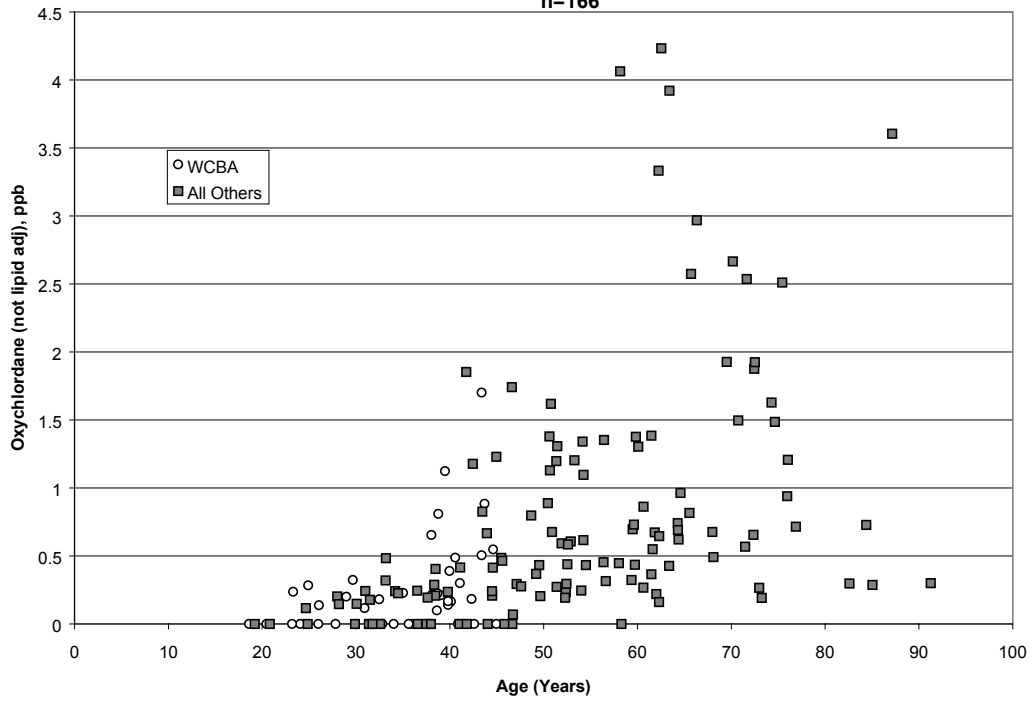


Figure 10. t-Nonachlor serum levels (ppb) and Age
5 Aleutian and Pribilof Villages, Alaska 1999
n=160

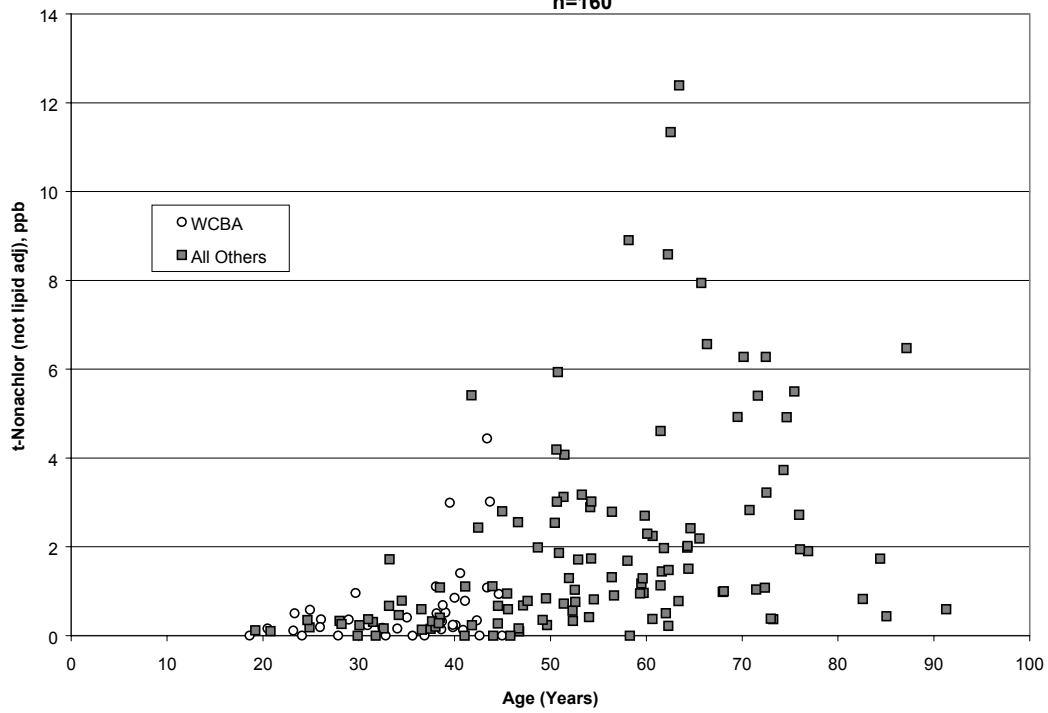


Figure 11. p,p'-DDE serum levels (ppb) and Age
5 Aleutian and Pribilof Islands, Alaska 1999
n=166

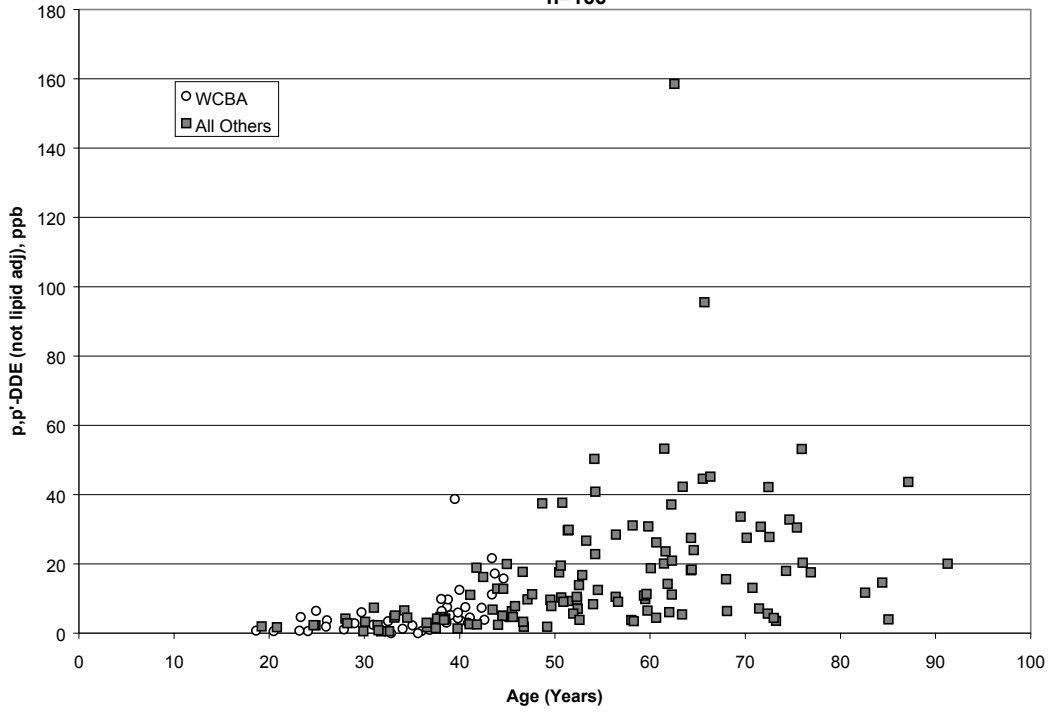


Figure 12. Dieldrin serum levels (ppb) and Age
5 Aleutian and Pribilof Villages, Alaska 1999
n=166

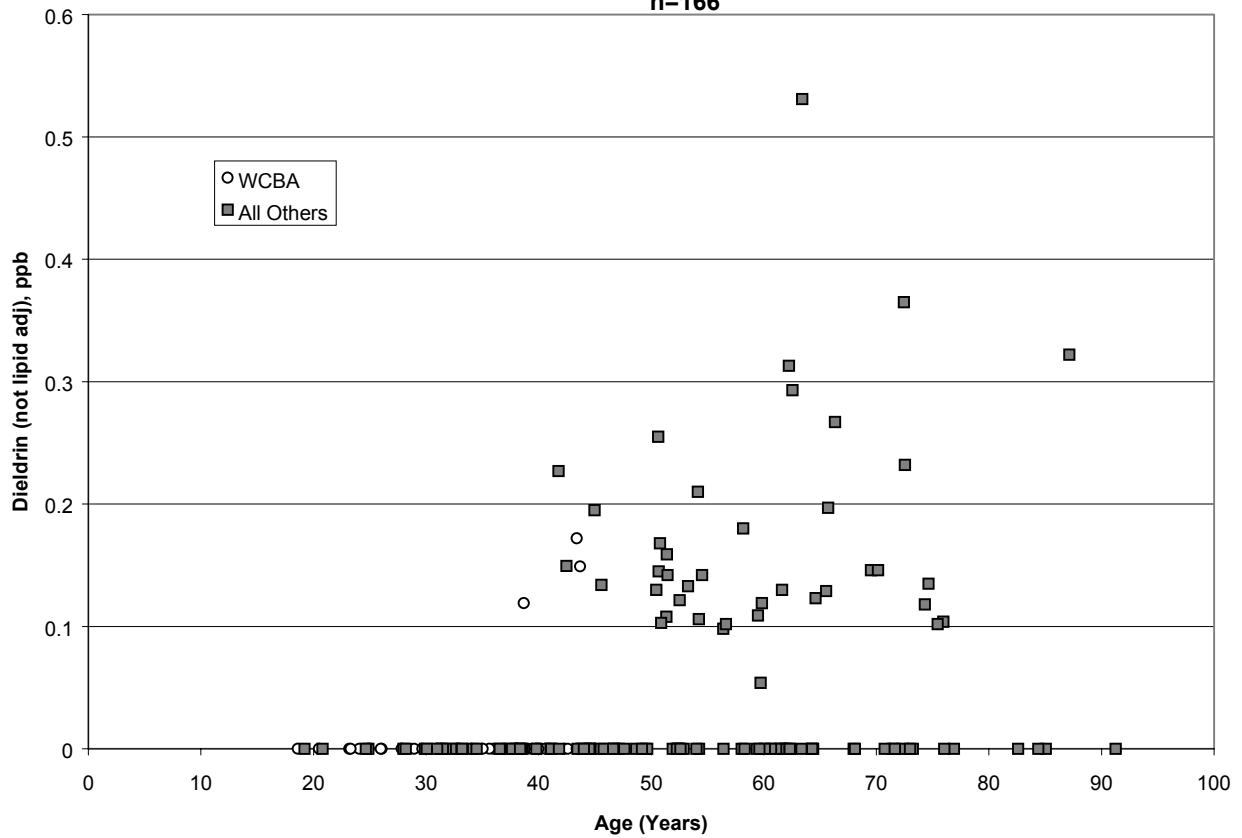


Figure 13. p,p'-DDT serum levels (ppb) and Age
5 Aleutian and Pribilof Island Villages, Alaska 1999
n=166

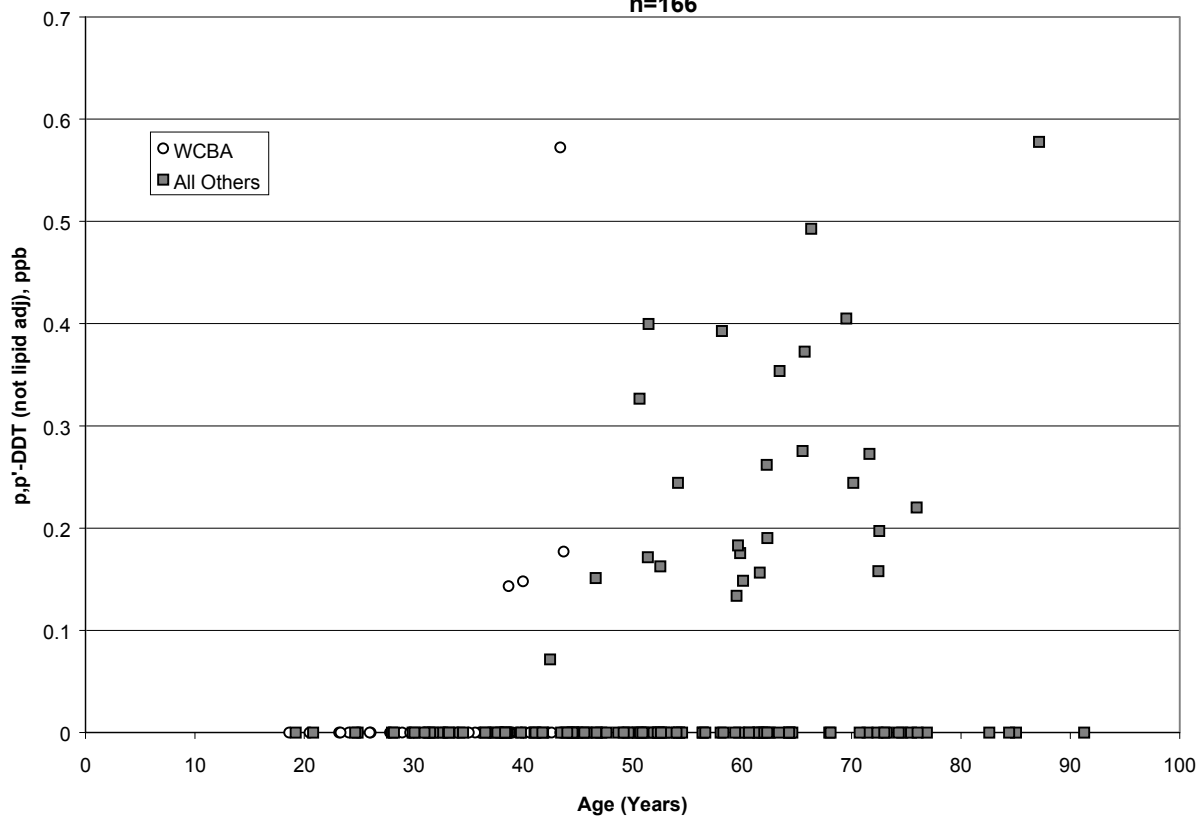
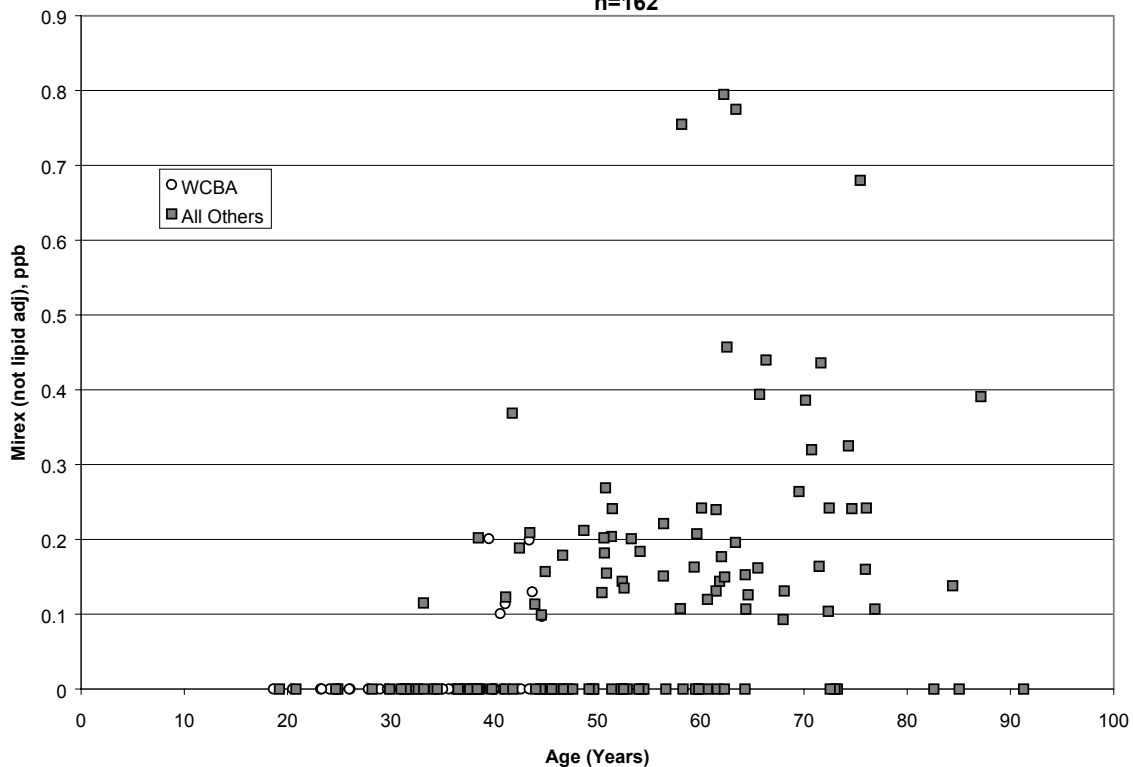


Figure 14. Mirex serum levels (ppb) and Age
5 Aleutian and Pribilof Islands, Alaska 1999
n=162



Exposure to POPs in the Aleutian and Pribilof Islands

What are POPs?

The name POPs is short for Persistent Organic Pollutants. POPs are man-made chemicals that do not disappear from the environment very easily. They can stay in the environment and end up far from where they were released. POPs include chemicals like PCBs and DDT. PCBs were widely used in electrical equipment, and pesticides were used to control insects in agricultural crops. Millions of tons were used around the world in the 1950s to 1970s. Another POP, called DDE, is a chemical found when the pesticide DDT has deteriorated, or broken down. In the environment, DDT quickly changes to DDE. DDE is more stable and will remain unchanged for a long time.

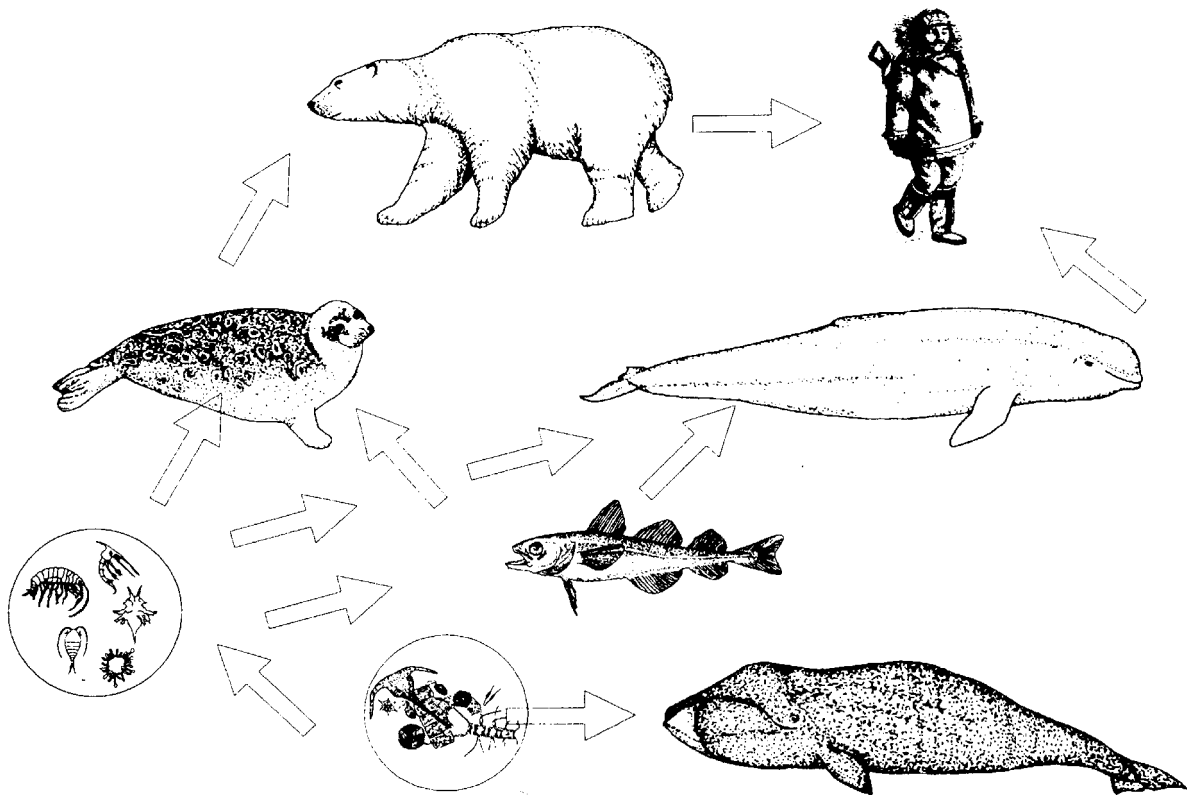
Where do POPs come from?

Most of the POPs found in traditional foods are thought to come to Alaska from other parts of the world, but some may come from local sources too. POPs remain in the environment for long periods of time. POPs can evaporate, be carried north by

the wind, and get redeposited in rain and snow. POPs and some other contaminants can reach Alaska from the lower 48, Canada, and other industrialized nations like Russia. PCBs and DDT were banned in the U.S. over 20 years ago, but some developing countries still use them. When POPs reach Alaska and other places in the Arctic, they tend to evaporate less and less because of colder temperatures. For this reason POPs tend to collect in the Arctic. In most places such as the lower 48, levels of POPs like PCBs and DDT are decreasing since the chemicals have been banned for over 20 years. There is not much information on whether or not levels are decreasing in Alaska.

How do POPs get into my body?

When a human or animal eats a plant or another animal, it is exposed to all the POPs stored in that food. Humans and other animals at the top of the food chain can build up the highest levels of POPs. This is called biomagnification.



Some POPs can be stored in the body for a long time. POPs are stored in the body's fat, and as humans and animals grow older they slowly build up POPs in their fat. This is called bioaccumulation.

In general, levels of POPs in air, water, and soil are small. But because of biomagnification and bioaccumulation almost everyone has measurable amounts of POPs in their bodies. POPs are found in all people, food chains, and in many store-bought foods.

Can POPs in traditional foods make me sick?

The amounts of POPs in traditional foods are too small to cause illness. The main health concern about POPs in traditional foods is the possibility that they could cause harm to unborn and new born babies. Research studies have given special attention to possible harmful effects that POPs could have on babies. Most of the studies have shown no effects. However, some studies have shown very small effects on children's development. These potential effects are extremely small. It is important to know that we recommend that mothers continue to breast-feed. Breast milk is still by far the healthiest food for your newborn baby.

Should I eat traditional food in the Aleutian and Pribilof Islands?

Yes. We strongly recommend that you continue eating traditional foods. Some traditional foods in the Aleutian and Pribilof Islands contain small amounts of man-made chemicals, or POPs, but traditional foods are still by far the best food choice you can make. Traditional foods are high in important vitamins and minerals. Traditional foods contain nutrients that fight cancer and lower risk of heart disease. Some health problems once rare among Alaska Natives, like diabetes, have appeared when traditional foods were abandoned for store-bought foods. Some people living in the Arctic who stopped eating traditional foods experienced increased body weight, a blood condition called anemia, and less resistance to sickness. It is more difficult to get a healthy diet

from store-bought foods. Many store-bought foods contain very small amounts of the same chemical contaminants found in traditional foods. The benefits of traditional foods far outweigh the very small, potential harmful health effects of POPs.

Can POPs in traditional foods cause cancer?

The levels, or amounts, of POPs found in traditional food are too small to cause cancer. POPs at these levels have not been shown to cause cancer in any human population. Cancer is a group of more than 200 diseases rather than one single disease. There are different causes for different types of cancer. Cancer is a natural process that can happen as we grow older and the body's defenses slow down.

Alaska Natives are living longer now than ever before. Since cancer is more common among older people, more Alaska Natives are getting cancer. The vast majority of cancers in Alaska Natives occur in people over 50 years of age.

The two things that contribute the most to all types of cancer are tobacco use and diet. Not smoking or using other forms of tobacco and eating a healthy diet are by far the greatest things you can do to decrease your risk of getting cancer. Traditional foods are very high in cancer-fighting agents.

Why was the blood of village volunteers sampled?

For many years Alaska Natives have been concerned about contaminants in traditional foods. Recent warnings from some scientists and the news media against eating traditional food in the Aleutian and Pribilof Islands have increased these concerns. The State of Alaska Division of Public Health, Section of Epidemiology (DPH) has been investigating concerns about traditional foods for many years. The villages, Tribes, and the Aleutian/Pribilof Islands Association asked DPH's assistance in investigating exposure to contaminants through traditional foods. DPH asked volunteers to give blood samples to be tested for POPs.

What were the results of the blood testing?

We expected to find POPs including PCBs and pesticides in village members' blood, because everyone has small amounts in their bodies. The PCB levels found in volunteers' blood were similar to those in the lower 48, in other arctic nations, and in Alaska Natives in some other parts of the state. The pesticide levels found in blood were similar to, but slightly higher than, other arctic nations. The levels of POPs found are not of health or medical concern. Village members do not need to take any medical action. No medical examination, tests, or treatments are recommended because of the presence of POPs. People in the Aleutian and Pribilof Islands should continue to eat traditional foods.

What if I want to cut down on the amount of POPs I eat?

We strongly recommend that you continue eating traditional foods. It is by far your most healthy food choice. However, if individuals want to lower potential exposures to POPs, we suggest the following:

- Choose animals lower on the food chain and younger animals. POPs levels tend to be higher in older, male animals at the top of the food chain. For example, toothed whales tend to have higher POPs levels than baleen whales. In studies conducted to date, killer whales, beluga whales, Pacific walrus, Steller sea lions, and northern fur seals appear to have the highest levels of POPs. POPs are stored in fatty tissue, so POPs levels will be higher in blubber and skin than in other tissues.

What should the Aleutian and Pribilof Villages do next?

To address concerns and answer more questions about POPs and other contaminants in traditional foods, the villages may want to consider:

- **Additional POPs blood testing in villages in the Aleutian Chain.** This would provide more information about levels of POPs in the area of the Aleutian Islands.
- **Gathering information about POPs levels in women of childbearing age.** Measuring levels of POPs in mothers, infant cord blood, and breast milk would provide more valuable information about the potential exposure of mothers, babies, and children, which are of most concern.
- **Compiling information about the use of traditional foods.** This could provide information about whether or not exposures were higher in the past, or have remained the same. We support the sampling of wildlife and traditional foods to add to this knowledge base. Measuring levels of POPs in birds and marine mammals would be of value in determining potential human exposure and for monitoring trends.
- **Future blood testing over time.** Together with information on traditional food use, this would provide information on the trends of levels of contaminants in traditional foods.

These activities could add a lot of information to what is known about contaminants in traditional foods in the Aleutian and Pribilof Islands and in Alaska. They could also answer more questions that people may have about this issue. This knowledge could be very useful to Native and non-Native people of Alaska and the Arctic. These and any other public health investigations should only be carried out in the support of each village.

Glossary

Anemia: A blood condition that occurs when there is a lack of essential nutrients in the blood.

Bioaccumulation: Some chemicals like POPs can be stored in the body for a long time. POPs are stored in the body's fat, and as humans and animals grow older they slowly build up POPs in their fat. Since POPs accumulate in the body, as we age we expect that older people will have higher levels of POPs in their bodies than younger people will.

Biomagnification: When a human or animal eats a plant or another animal, it is exposed to all the POPs stored in that food. For this reason, levels of POPs increase in animals higher up the food chain. Humans and other animals at the top of the food chain can build up the highest levels of POPs.

Contaminant: Any substance that is found in a place where it should not be. A common example is oil. However, contaminants can be found naturally in the environment also. Contaminants are not always harmful.


DDT: A pesticide widely used to control insects worldwide prior to the 1970s. DDT was very cheap to produce and very effective. However, it was discovered that it did not break down in the environment and could cause health effects in animals and people. DDT was banned in the U.S. in 1972. It is still used in developing countries today.

DDE: DDE is a break down product of DDT. In the environment, DDT quickly changes to DDE. DDE is more stable and will remain unchanged for a long time. DDE is only found in the environment as a result of contamination or breakdown of DDT.

Exposed: When a chemical gets into your body.

PCBs: Polychlorinated Biphenyls. A group of many man-made industrial chemicals used widely in electrical equipment such as capacitors and transformers. PCBs are very stable and resistant to heat and breakdown, making them ideal for use as heat transfer fluids and lubricants. Their attractive qualities for industry make them undesirable in the environment because they don't disappear. PCBs were banned in the U.S. in 1977.

Pesticides: Different man-made chemicals used to kill insects to prevent spread of human disease and to protect crops. The pesticides of concern share common properties. They all have chlorine in them, they all are stored in fat in humans' and animals' bodies, and they all last a long time in the environment. They are all POPs.

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