Health Consultation

EXPOSURE INVESTIGATION

Investigation of Persistent Organic Pollutants in
Reindeer on St. Lawrence Island

N. E. CAPE WHITE ALICE SITE
(a/k/a N. E. CAPE SITE)

ST. LAWRENCE ISLAND, ALASKA

SEPTEMBER 21, 2001

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Summary of the Exposure Investigation

This exposure investigation examines reindeer, a significant source of food on St. Lawrence Island, for the presence of polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), and organochlorine pesticides. This information will be provided to the local communities at Gambell and Savoonga, and will supplement information from the ongoing Reindeer Research Program at the University of Alaska, Fairbanks. In general, levels of all contaminants analyzed were low. We conclude that no health problems related to the group of chemicals analyzed in this exposure investigation would be expected in individuals consuming a diet containing large quantities of reindeer meat and fat.

Background

The Alaska Native community on St. Lawrence Island, Alaska, live near a formerly used defense site. This defense site, the Northeast Cape site, was used by the military for activities during and after World War II. This area has traditionally been used by the Siberian Yupik community for harvesting, hunting and fishing. Summer fishing camps are still located near the site.

Contaminants such as heavy metals have been found in the environment in previous work done by the Reindeer Research Program at the University of Alaska, Fairbanks. These contaminants have been detected in plants which are consumed by the free-ranging reindeer. These reindeer are a food supply for the local population which depends on a subsistence diet.

The question addressed by this exposure investigation is whether persistent organic pollutants might also be present in reindeer at levels which could result in health problems for the local population. This exposure investigation collected data to evaluate this pathway by analyzing reindeer blood (serum), meat (muscle), and fat (adipose tissue) from animals already being sampled by the Reindeer Research Program during the Year 2000 reindeer roundup. It was performed in conjunction with the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPMS). This information will assist our response to the health concerns from the community.

Reindeer Overview

Reindeer (Rangifer tarandus) are semi-domesticated caribou. Although similar, there are fundamental differences in the behavior of reindeer and their wild cousins, caribou. Reindeer have been present in Eurasia for thousands of years. It is believed they have been domesticated there for at least 7000 years, which is longer than the horse (Edwards, 1994). In Eurasia reindeer are classified as either domesticated or wild, while in North America they are called reindeer if they are of the Eurasian domesticated variety, or caribou if they are of the wild variety. This domesticated factor makes them different from caribou in that they need to be tended on the range to keep them safe from predators, and may need to be driven to a better grazing area if theirs becomes sparse. They tend to be smaller than caribou, with shorter legs, and are a lighter color. They may have a life expectancy of 10-15 years, but mortality factors including disease and predation, not to mention unpredictable weather may cause them to die prematurely.

Reindeer eat lichen in winter and spring, and grass, birch and willow leaves, and mushrooms during the summer. They will always try to go to where the new greens are, which may be contrary to the direction the herder wants the herd to go.

Average reindeer weights (University of Alaska, Fairbanks–Reindeer Research Program).

Adults-	Female Average June Weight-	73.8 Kg	162.36 lbs.
	Female Average January Weight-	85.4 Kg	187.88 lbs.
	Male Average June Weight-	99.6 Kg	219.12 lbs.
	Male Average January Weight-	92.3 Kg	203.06 lbs.

Reindeer herding is an important cultural and economic part of life in many villages in Alaska. A concern expressed by some community members is that contaminants are being introduced into the food chain and compromising their health (Alaska Native Science Commission 1998). Current research programs, such as the Reindeer Research Program at the University of Alaska, Fairbanks, have analyzed heavy metals in reindeer, caribou, and native plants These heavy metals are readily absorbed by plants that are in turn eaten by ungulates, concentrating in liver, kidney, and muscle tissue (Gamburg and Scheuhammer, 1992).

Methods

This exposure investigation examined possible contamination of reindeer with PCBs, PAHs, and organochlorine pesticides. It was performed in conjunction with the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPMS). Serum from 25 animals in last year's (2000) reindeer roundup was collected. Adipose tissue and edible meat (muscle) was collected from 8 animals which were already being sacrificed and tested under the University of Alaska Reindeer Research Program. Organ meat was not tested in this exposure investigation. Tissue and serum were shipped frozen. Analysis was performed by the U.S. Army Corps of Engineers Environmental Chemistry Branch Lab using standard EPA methodology for these substances (i.e. EPA 8270C, EPA 8081A, EPA 8082). Data validation was performed by Science Applications International Corporation, Oak Ridge, Tennessee.

Results

Table 1 (see Attachment 1) summarizes the data collected on PCBs, PAHs, and pesticides in reindeer serum, muscle, and fat. PCBs were not detected at levels above the 25 ug/L detection level. Organochlorine pesticides were also present only at levels slightly above the method detection limit and well below any health-based comparison values. Seven of the PAHs were present in levels which were accurately quantified.

Discussion

Reindeer are usually consumed from November through December, during the major herding time. Sometimes there is a hunt in July or August as well. Organ meat such as heart and liver may be

eaten, however there is some disagreement over how commonly this happens. The hind and fore quarters, and spine meat, are regularly consumed. The fat is eaten and not trimmed off. Meat is generally boiled, but may also be fried, baked, broiled or dried.

In general, levels of all contaminants analyzed were low. (See attached table for specific values.) Only benzo (a) anthracene was present at a quantifiable concentration in muscle that was slightly above a health-based comparison value. Because a Minimal Risk Levels (ATSDR's health based comparison values) are currently not available for benzo (a) anthracene and many of the PAHs, EPA's oral reference doses or oral cancer slope factors were used as screening values for these chemicals.

Several other PAHs (benzo(b)fluoranthene, benzo(a)pyrene, indo(1,2,3-cd)pyrene, and dibenzo(a,h)anthracene) were found at levels above detection values, but too low to be accurately quantified. These four chemicals may, or may not, be at concentrations above their respective screening levels. It is important to note that these are *estimated* concentrations which were not considered accurately quantified.

Small amounts of benzo (a) anthracene were found in the muscle of 6 out of 8 reindeer slaughtered. The maximum concentration in muscle tissue was 22 ng/g (ppb). A risk calculation for an individual eating a large amount of reindeer meat and fat is included in Attachment 2. It is apparent from this risk calculation that consumption of reindeer meat and fat on St. Lawrence Island does not significantly increase an individuals risk of cancer.

Conclusions

1. Based on the analysis of PCB, PAH, and pesticide levels from the 2000 reindeer roundup, detectable health effects are not expected in individuals consuming reindeer muscle and fat on St. Lawrence Island.

Recommendations

1. Continue the usual local consumption patterns of reindeer meat and fat.

2. ATSDR will consider repeat analysis of these chemicals in a future reindeer harvest (2002 or 2003) to determine any change in contamination levels.

3. Consider analysis of organ meat (e.g. liver, kidney, heart) in any future sampling.

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Exposure Investigations and Consultations Branch
Division of Health Assessment and Consultation

References

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5. Gamberg, M., and Scheuhammer, A.M. 1992. Cadmium in caribou and muskoxen from the Canadian Yukon and Northwest Territories, In: Sci. of the Total Environ. 143 (1194) 221-234.

Attachment 1

Table 1. Levels of PCBs, PAHs, and Pesticides in Reindeer Serum, Muscle, and Fat from the Savoonga Area.

Attachment 1

Table 1. Levels of PCBs, PAHs, and Pesticides in Reindeer Serum, Muscle, and Fat from the Savoonga Area.

Chemical	Serum			Muscle			Fat		
	detects	max.	m.d.l.	detects	max.	m.d.l.	detects	max.	m.d.l.
	(#/total)	(ug/L)	(ug/L)	(#/total)	(ng/g)	(ng/g)	(#/total)	(ng/g)	(ng/g)
Total PCB	0/25	n.d.	25	0/8	n.d.	3	0/8	n.d.	3
Naphthalene	0/12	n.d.	0.02	6/8	11 J	2.8	0/8	n.d.	2.8
2-Methylnaphthalene	0/12	n.d.	0.02	1/8	4.8 J	1.2	0/8	n.d.	1.2
Acenaphthylene	0/12	n.d.	0.02	1/8	3.9 J	0.8	0/8	n.d.	0.8
Acenaphthene	0/12	n.d.	0.02	4/8	14 J	0.8	0/8	n.d.	0.8
Fluorene	0/12	n.d.	0.02	4/8	19	1.7	0/8	n.d.	1.7
Phenanthrene	0/12	n.d.	0.02	8/8	67	1.2	0/8	n.d.	1.2
Anthracene	0/12	n.d.	0.02	6/8	40	1.5	1/8	3.7 ng/g J	1.5
Fluoranthene	0/12	n.d.	0.02	7/8	48	1.7	1/8	5.5 ng/g J	1.7
Pyrene	0/12	n.d.	0.02	7/8	40	1.2	1/8	5.5 ng/g J	1.2
Benzo (a) anthracene	0/12	n.d.	0.02	6/8	22	1.9	0/8	n.d.	1.9
Chrysene	0/12	n.d.	0.02	5/8	19	1.9	0/8	n.d.	1.9
Benzo (b) fluoranthene	0/12	n.d.	0.01	5/8	16 J	2.3	0/8	n.d.	2.3
Benzo (k) fluoranthene	0/12	n.d.	0.01	5/8	12 J	2.4	0/8	n.d.	2.4
Benzo (a) pyrene	0/12	n.d.	0.008	5/8	12 J	2.1	0/8	n.d.	2.1
Indeno (1,2,3-cd) pyrene	0/12	n.d.	0.01	4/8	8.7 J	2.7	0/8	n.d.	2.7
Dibenzo (a,h) anthracene	0/12	n.d.	0.009	3/8	6.8 J	2.8	0/8	n.d.	2.8
Benzo (g,h,I) perylene	0/12	n.d.	0.007	3/8	7.4 J	2.3	0/8	n.d.	2.3
Aldrin	0/25	n.d.	2.5 ug/L	0/8	n.d.	0.4	0/8	n.d.	0.4
Alpha BHC	1/25	2.0 J	2.5 ug/L	0/8	n.d.	0.5	0/8	n.d.	0.5
Beta BHC	1/25	2.3 J	2.5 ug/L	0/8	n.d.	0.8	0/8	n.d.	0.8
Delta BHC	2/25	2.0 J	2.5 ug/L	0/8	n.d.	0.4	0/8	n.d.	0.4
Gamma BHC (Lindane)	0/25	n.d.	2.5 ug/L	0/8	n.d.	0.4	0/8	n.d.	0.4
4,4'-DDD	0/25	n.d.	5.0 ug/L	0/8	n.d.	1	0/8	n.d.	1
4,4'-DDE	0/25	n.d.	5.0 ug/L	0/8	n.d.	0.4	0/8	n.d.	0.4
4,4'-DDT	3/25	5.0 J	5.0 ug/L	0/8	n.d.	0.4	0/8	n.d.	0.4
Dieldrin	0/25	n.d.	5.0 ug/L	0/8	n.d.	0.4	0/8	n.d.	0.4
Alpha endosulfan	0/25	n.d.	2.5 ug/L	0/8	n.d.	0.3	0/8	n.d.	0.3
Beta endosulfan	0/25	n.d.	5.0 ug/L	0/8	n.d.	0.4	0/8	n.d.	0.4
Endosulfan sulfate	0/25	n.d.	5.0 ug/L	1/8	0.87 J	0.8	0/8	n.d.	0.8
Endrin	0/25	n.d.	5.0 ug/L	4/8	3.0 J	0.8	0/8	n.d.	0.8
Endrin aldehyde	0/25	n.d.	5.0 ug/L	3/8	1.9 J	1	0/8	n.d.	1
Heptachlor	1/25	1.1 J	2.5 ug/L	4/8	0.56 J	0.5	0/8	n.d.	0.5
Heptachlor epoxide	0/25	n.d.	2.5 ug/L	0/8	n.d.	0.4	0/8	n.d.	0.4
Methoxychlor	0/25	n.d.	25 ug/L	0/8	n.d.	2	0/8	n.d.	2
Alpha chlordane	1/25	1.3 J	2.5 ug/L	1/8	1.0 J	0.4	0/8	n.d.	0.4
Gamma chlordane	0/25	n.d.	2.5 ug/L	0/8	n.d.	0.4	0/8	n.d.	0.4

m.d.l. = method detection limit

n.d. = non-detect

J = estimated concentration

Attachment 2

Risk calculation for benzo (a) anthracene exposure:

Small amounts of benzo (a) anthracene were found in the muscle of 6 out of 8 reindeer slaughtered. The maximum concentration in muscle tissue was 22 ng/g (ppb). An individual who consumed 1 kg (2.2 lbs) of reindeer meat each day for 4 months of the year would, over a 70 year lifetime, have an excess cancer risk of 7.7×10^{-5}.

$$\frac{C \times CF \times IR \times EF \times ED}{BW \times AT} = \frac{22\ ng/g \times (10^{-6}\ mg/ng \times 10^{3}\ g/kg) \times 1\ kg/d \times 4\ mo/12\ mo \times 70\ yr}{70\ kg \times 70\ yr} = 1.05 \times 10^{-4}\ mg/kg\text{-}d$$

Dosage x CSFo = 1.05×10^{-4} mg/kg-day x 0.73 $(mg/kg\text{-}day)^{-1}$ = 7.7×10^{-5} excess cancer risk

C = concentration in meat/fat
CF = conversion factors of ng to mg and g to kg
IR = ingestion rate
EF = exposure frequency
ED = exposure duration
BW = body weight
AT = averaging time
CSFo = oral cancer slope factor*

***Note that this is a *provisional* cancer slope factor and may reflect much uncertainty in predicting risk.**

Sample Numbers for Serum Samples Only
1 (serum)
2 (serum)
3 (serum)
6 (serum)
8 (serum)
9 (serum)
11 (serum)
12 (serum)
13 (serum)
14 (serum)
16 (serum)
17 (serum)
18 (serum)
19 (serum)
20 (serum)
21 (serum)
31 (serum)

Total Samples = 17 serum

Sample Numbers for Serum Samples w/associated fat & muscle samples with the same sample number
22 (serum, fat & muscle)
23 (serum, fat & muscle)
24 (serum, fat & muscle)
25 (serum, fat & muscle)
26 (serum, fat & muscle)
27 (serum, fat & muscle)
29 (serum, fat & muscle)
30 (serum, fat & muscle)

Total number of samples = 24 (serum, fat & muscel)

Total Number of Serum samples only 17
Total Number of Serum samples with corresponding fat & muscle samples 8
Total number of fat samples 8
Total number of muscle samples 8
Total number of samples 41

WES-EE-C
COOLER RECEIPT FORM

ECB Log-in # _____ Date Received: 7/11/00

Project: Reindeer Research Program

USE OTHER SIDE OF THIS FORM TO NOTE DETAILS CONCERNING CHECK-IN PROBLEMS.

A. PRELIMINARY EXAMINATION PHASE:

Date cooler opened: 7/11/00 by (print) Linda K. Stevenson

(signature) Linda K Stevenson

Did cooler come with a shipping slip (air bill, etc.) ..... (YES) NO

If YES, enter carrier name & air bill number here: F.E.X. 806648731216

*1. Were custody seals on outside of cooler? ..... YES (NO)

How many & where: _____ seal date: _____ seal name: _____

2. Were custody seals unbroken and intact at the date and time of arrival? ..... (YES) NO

3. Were custody papers sealed in a plastic bag & taped inside to the lid? ..... YES (NO)

4. Were custody papers filled out properly (ink, signed, etc.)? ..... YES (NO)

5. Did you sign custody papers in the appropriate place? ..... (YES) NO

*6. Was project identifiable from custody papers? If YES, enter project name at the top of this form ..... YES NO

7. If required, was enough ice used? (Type of ice: Cubed) (Temperature: 9°C) ..... YES (NO)

8. Have designated person initial here to acknowledge receipt of cooler: lbs (date) 7/11/00

B. LOG-IN PHASE:

Date samples were logged-in: _____ by (print) _____

(signature) _____

9. Describe type of packing in cooler: _____

10. Were all bottles sealed in separate plastic bags? ..... YES NO

11. Did all bottles arrive unbroken & were labels in good condition? ..... YES NO

12. Were all bottle labels complete (ID, date, time, signature, preservative, etc.)? ..... YES NO

13. Did all bottle labels agree with custody papers? ..... YES NO

14. Were correct containers used for the tests indicated? ..... YES NO

15. Were correct preservatives added to samples? ..... YES NO

16. Was a sufficient amount of sample sent for tests indicated? ..... YES NO

17. Were bubbles absent in Volatile samples? If NO, list by Project ID #: _____ YES NO

18. Was the project manager called and status discussed? If YES, give details on the back of this form .... YES NO

19. Who was called? _____ By whom? _____ (Date) _____

* 1. no custody seals but "Evidence" tape was on cooler & intact.

#6. Accompanying paper identified Project.

Dr. Denise MacMillan called Mike White, this project is on hold until funding is received.

CHAIN OF CUSTODY RECORD

Date Extracted: _____
Date Digested: _____
Date Analyzed: _____

Account:	DataChem Set ID:	Sponsor:	SPLITS				
Field Comment:							

Date Sampled	Field ID Number	DataChem Sample Number(s)	Sample Matrix	Number of Containers	Remarks

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Todd Nichols	7/6/00 1300	Lenda K. Stevens 7/10/00			
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Final Disposition: _____ Signature: _____

Savoonga / St. Lawrence Is
Alaska Reindeer

Blood / Tissue Samples
Taken 7-1-00

Numbers #1 Thru → #31
and #31 Thru → #35
are serum samples only
(No Tissue)
(3x (5ml) vials each)

Serum samples #22 Thru #
each have corresponding
back-fat and muscle
Tissue samples

* The 3 extra Tissue
samples marked NB
have "No Blood" serum
samples To match w/

*** #28 Thru → #34 are
from N.E. Cape Bulls

Greg L. Finstad
UAF Reindeer Research Program
Box 757200, UAF / 303 O'Neil
Fairbanks, AK 99775-7200

(907) 474-6055

Todd Nichols -7101
(person who sampled)

Samples with Rachel
-9°C Plane 7/11/00 1442

FedEx. USA Airbill 8066 4873 1216 0210 Recipient's Copy

1 From 7/10
Sender's Name Mike Whitely Phone (410) 436-5221
Company USACHPPM + EHRA RLP
Address BLDG E-1677
Dept/Floor/Suite/Room
City ABERDEEN PROVING GROUN State MD ZIP 21010
2 Your Internal Billing Reference Information

3 To
Recipient's Name Steve LAWSON Phone (601) 634-3431
Company US Army Corps of Engineers - WATERWAYS EXP STATION
Address 3909 Halls Ferry ROAD Check here if residence
Dept/Floor/Suite/Room
City Vicksburg State MS ZIP 39180-6199
For HOLD at FedEx Location check here
Hold Weekday (Not available with FedEx First Overnight)
Hold Saturday (Available for FedEx First Overnight, FedEx Priority Overnight and FedEx 2Day only)
For WEEKEND Delivery check here (Some Areas Not Available as Noted)
Saturday Delivery (Available for FedEx Priority Overnight and FedEx 2Day only)
NEW Sunday Delivery (Available for FedEx Priority Overnight only)

4a Express Package Service
FedEx Priority Overnight
Standard Overnight
FedEx First Overnight
FedEx 2Day
FedEx Express Saver (Not available)
4b Express Freight Service - Packages over 150 lbs.
FedEx 1Day Freight
FedEx 2Day Freight
FedEx Express Saver Freight
Delivery commitment may be later in some areas
Call for delivery schedule. Declare value, pay additional charge, and see Terms and Conditions for limitations of liability.
5 Packaging
FedEx Envelope
FedEx Pak
FedEx Box
FedEx Tube
Other
6 Special Handling
SATURDAY Delivery NOT available for FedEx First Overnight
No
Yes
Dry Ice
Cargo Aircraft Only
7 Payment
Bill to: Sender
Recipient
Third Party
Credit Card
Cash/Check
Total Packages 20
Total Weight
Total Declared Value* $ .00
Total Charges $
Credit Card Auth.
*Declared value is limited to $100 unless you declare a higher value. See back for details.
8 Release Signature
Your signature authorizes Fedex Express or its agent to deliver this shipment without obtaining a signature and agrees to indemnify Fedex Express and its agents from any resulting claims.
321
Questions? Call 1-800-Go-FedEx® (800)463-3339
Rev. Date 3/98 Part #150855 ©1994-98 FedEx PRINTED IN U.S.A.
8066 4873 1216
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envt# 342415 18JUL00
TRK# 8066 4873 1216 FORM 0210
Deliver By: 11JUL00 AM
39180 MS-US
MEM
XO JANA

UAF Reindeer Research Program

The following samples were received on 11 July 2000 at 1420 hours.
There appeared to be some leaking of the Serum samples as moisture was present in the box of vials

The following vials were received:

1 (3 vials)
2 (3 vials)
3 (3 vials)
4 (3 vials, 1 ½ vials were empty)
5 (3 vials, 2 vials were empty)
6 (3 vials)
7 (3 vials, 1 of the vials was empty)
8 (3 vials)
9 (3 vials)
10 (3 vials, 1 of the vials was ½ full)
11 (3 vials)
12 (3 vials)
13 (3 vials)
14 (3 vials)
15 (3 vials, 1 of the vials was empty)
16 (3 vials)
17 (3 vials)
18 (3 vials)
19 (3 vials)
20 (3 vials)
21 (3 vials)
22 (3 vials)
23 (3 vials)
24 (3 vials, 1 of the vials was ¾ full)
25 (3 vials)
26 (3 vials)
27 (3 vials), 1 of the vials was ¾ full)
28 (3 vials), 1 of the vials was ½ full)
29 (3 vials)
30 (3 vials)
31 (3 vials)
32 (3 vials)
33 (3 vials)
34 (3 vials)
35 (3 vials)

The following numbers were also in cooler:

22 (2 jars)
23 (2 jars)
24 (2 jars)
25 (2 jars)
26 (2 jars)
27 (2 jars)
26 (2 jars)
27 (2 jars)
28 (2 jars)
29 (2 jars)
30 (2 jars)

There were 6 jars labeled NB