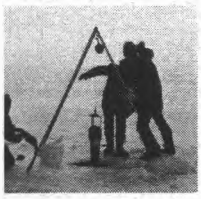
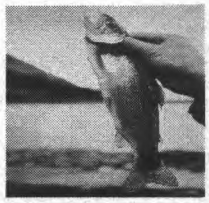
Canada Alberta Northwest Territories

Northern River Basins Study





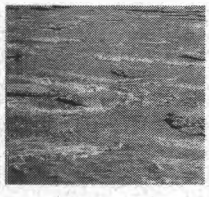


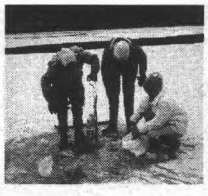



NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 48

ENVIRONMENTAL CONTAMINANTS IN PRE-FLEDGED COMMON MERGANSERS

WAPITI RIVER, AUGUST, 1992






DATE DUE

Prepared for the
Northern River Basins Study
under Project 2363-C1

by

Mark Wayland
Canadian Wildlife Service

NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 48

ENVIRONMENTAL CONTAMINANTS IN PRE-FLEDGED COMMON MERGANSERS

WAPITI RIVER, AUGUST, 1992

Published by the
Northern River Basins Study
Edmonton, Alberta
April, 1995

CANADIAN CATALOGUING IN PUBLICATION DATA

Wayland, Mark

Environmental contaminants in pre-fledged common mergansers, Wapiti river, August, 1992

(Northern River Basins Study project report,
ISSN 1192-3571 ; no. 48)
Includes bibliographical references.
ISBN 0-662-23437-5
Cat. no. R71-49/3-48E

1. Mergansers -- Effect of water pollution on -- Alberta -- Wapiti River.
2. Wood-pulp industry -- Alberta -- Wapiti River -- Environmental aspects.
3. Environmental monitoring -- Alberta -- Wapiti River.
I. Northern River Basins Study (Canada)
II. Title.
III. Series.

QL696.A52W39 1995 598.4'1 C95-980134-0

PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

NORTHERN RIVER BASINS STUDY
PROJECT REPORT RELEASE FORM

This publication may be cited as:

Wayland, Mark. 1995. ***Northern River Basins Study Project Report No. 48, Environmental Contaminants in Pre-Fledged Common Mergansers, Wapiti River, August, 1992*** **, Northern River Basins Study, Edmonton, Alberta.**

Whereas the above publication is the result of a project conducted under the Northern River Basins Study and the terms of reference for that project are deemed to be fulfilled,
IT IS THEREFORE REQUESTED BY THE STUDY OFFICE THAT;
this publication be subjected to proper and responsible review and be considered for release to the public.

F. J. Wrona — 10 April 95

(Dr. F. J. Wrona, Ph.D., Science Director) (Date)

Whereas it is an explicit term of reference of the Science Advisory Committee "to review, for scientific content, material for publication by the Board",
IT IS HERE ADVISED BY THE SCIENCE ADVISORY COMMITTEE THAT;
this publication has been reviewed for scientific content and that the scientific practices represented in the report are acceptable given the specific purposes of the project and subject to the field conditions encountered.
SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [ ] Yes [ ] No

P. A. Larkin — 12 April 95

(Dr. P. A. Larkin, Ph.D., Chair) (Date)

Whereas the Study Board is satisfied that this publication has been reviewed for scientific content and for immediate health implications,
IT IS HERE APPROVED BY THE BOARD OF DIRECTORS THAT;
this publication be released to the public, and that this publication be designated for: **[ ] STANDARD AVAILABILITY [ ] EXPANDED AVAILABILITY**

Lucille Partington — 12/04/95

(Lucille Partington, Co-chair) (Date)

Robert McLeod — 12/04/95

(Robert McLeod, Co-chair) (Date)

ENVIRONMENTAL CONTAMINANTS IN PRE-FLEDGED COMMON MERGANSERS, WAPITI RIVER, AUGUST, 1992

STUDY PERSPECTIVE

Environmental toxicologists now recognize the value of waterbirds, particularly fish-eating forms, as useful "monitors" for measuring environmental contamination. Some fish-eating species are capable of bioaccumulating lipid soluble contaminants in their body tissues to levels that are several fold higher than concentrations found in local water bodies. Because fish-eating birds and man share a common food source, the pollution that might affect waterbirds has the potential to directly affect the welfare of local human populations.

Related Study Questions

4a) *What are the contents and nature of the contaminants entering the system and what is their distribution and toxicity in the aquatic ecosystem with particular reference to water, sediments and biota?*

11) *Have the riparian vegetation and riparian wildlife in the river basins been affected by exposure to organochlorines or other toxic compounds?*

Within the Northern River Basins Study area, the common merganser appeared to represent an ideal waterbird species for monitoring pollutants originating from pulp mill effluents. In early August, 1992, pre-fledged common mergansers were collected upstream and downstream from the Weyerhaeuser Canada pulp mill on the Wapiti River near Grande Prairie. Four birds were collected upstream from the mill and six were collected downstream. Analyses of dioxins/furans and chlorinated phenolics were made on composite liver homogenates; one sample for each upstream and downstream site. Organochlorines, PCBs and metals were analyzed in liver or kidney tissue on an individual basis.

In general, few contaminants were detected and those that had measurable levels were found at very low concentrations. Some chlorinated phenolics were detected in the downstream composite sample but not in the upstream sample. Although concentrations were very low, 2,3,7,8-tetrachlorodibenzofuran occurred at higher levels downstream of Weyerhaeuser Canada than upstream, suggesting a pulp mill effect. PCBs, organochlorine insecticides and metals did not differ between sites. Vitamin A as retinol and retinyl palmitate was lower in livers of downstream mergansers than in ones found upstream. One explanation for this is the greater exposure of the downstream mergansers to contaminants such as dioxins and furans, members of a group of contaminants known to be associated with reduced stores of Vitamin A.

This preliminary study provides an interpretation of analytical results for contaminants that are known to bioaccumulate in the tissues of fish-eating birds. Common mergansers appear to be numerous enough on the Wapiti River to be considered a good species for monitoring contaminants from the Weyerhaeuser pulp mill at Grande Prairie. However, a more appropriate life stage may have to be considered in future studies. Pre-fledged mergansers in this study did not have time to accumulate significant body burdens of contaminants, and their rapid growth may have resulted in diluted contaminant concentrations in their tissues.

The Study's Science Advisory Committee reviewed the report and recognized that the samples are too small on which to base firm conclusions and should be considered only as exploratory. However, to the extent that this report indicates low levels of contaminants by comparison with rivers elsewhere, the findings are reassuring. Further studies will be necessary in the future.

REPORT SUMMARY

Among the guiding questions of the Northern River Basins Study, questions 4 and 11 ask about the nature and contents of the contaminants entering the system and about their effects on riparian wildlife, respectively. This report examines these questions by focusing on contaminants in one riparian species, the Common Merganser.

In early August, 1992, pre-fledged Common Mergansers were collected upstream and downstream from the Weyerhaeuser Canada pulp mill (formerly Proctor and Gamble) on the Wapiti River, near Grande Prairie, Alberta. Four birds were collected upstream from the mill and six were collected downstream from the mill. Analyses of dioxins and furans and chlorinated phenolics were made on pooled liver homogenates (n=1 for both the upstream and downstream sites). Organochlorine insecticides, PCBs and metals were analyzed in liver or kidney tissue on an individual basis.

In general, few contaminants were detected. Those that were, were found at very low concentrations. Some chlorinated phenolics were detected in the downstream pool but not in the upstream pool while 2378-tetrachlorodibenzofuran (TCDF) occurred at higher levels in the downstream pool than in the upstream pool, suggesting a pulp mill effect. However, the concentration of 2378-TCDF in the downstream pool was less than 10% of that in Common Mergansers downstream from a pulp mill on the St. Maurice River in Quebec. PCBs, organochlorine insecticides and metals did not differ between sites. Vitamin A as retinol and retinyl palmitate were lower in livers of downstream mergansers than in those of upstream ones. One explanation for this is the greater exposure of the downstream mergansers to contaminants such as 2378-TCDF, a member of a class of contaminants known to be associated with reduced stores of vitamin A.

ACKNOWLEDGEMENTS

G. Court and P. Hvenegaard of D.A. Westworth and Associates did the field sampling. Contaminant analyses were done by Enviro-Test Laboratories (dioxins and furans), Chemex Labs Alberta (metals) and Zenon Environmental Laboratories (organochlorines, PCBs and chlorophenolics). Tissue preparations and vitamin A analyses were done by the Canadian Wildlife Service (Hull, Quebec). Special thanks to D. Kennedy, Northern River Basins Study, for formatting the report.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Among the guiding questions of the Northern River Basins Study, questions 4 and 11 ask about the nature and contents of the contaminants entering the system and about their effects on riparian wildlife, respectively. To address these questions, many components of the ecosystem have been examined. This report deals with one species, the Common Merganser (*Mergus merganser*).

Common Mergansers are migratory, fish-eating birds associated with aquatic ecosystems. They inhabit coastal areas, large lakes and rivers during the winter. In spring they return to breeding areas where they take up residence on lakes, streams and rivers. The young are precocial, leaving the nest with the mother within a day or two after hatching and feeding themselves. They eat mainly small fish such as shiners, sculpins, suckers, minnows and salmonid fry (Stelfox 1977, Timken and Anderson 1969, White 1936, Vermeer *et al.* 1973). Mergansers often form 'gang' broods, consisting of several mothers and their young during the brood-rearing period. Pre-fledged mergansers were proposed as a bioindicator of contaminants exposure in riparian wildlife, primarily because their predatory nature and use of aquatic prey makes them a prime candidate for biomagnifying lipophilic organic contaminants such as PCBs which tend to accumulate in aquatic ecosystems. Also, pre-fledged birds would not have had an opportunity for picking up contaminants on wintering areas or at off-river sites. Finally, they are widely distributed (although not abundant), and it was originally thought that they would be a conspicuous and common member of the fauna of the Peace and Athabasca River systems, making field collections an easy task.

Because only limited information existed on contaminant levels in mergansers, and because no such information was available for mergansers in Alberta, it was decided to conduct a preliminary survey of contaminants in this species near pulp mills in Alberta by pooling liver homogenates to screen for dioxins, furans and chlorinated phenolics. If the pools indicated a large number of detectable levels, a decision could be made about doing further studies. Other contaminants, which were less expensive to analyze, were analyzed on an individual basis. The results of the analyses of pooled merganser liver homogenates are discussed in this report.

2.0 METHODS

In early August 1992, attempts were made to collect pre-fledged mergansers at three sites on the Wapiti and Athabasca Rivers. Broods were not seen at either of the 2 sites on the Athabasca. However, mergansers were collected on the Wapiti. Four birds were shot about 30 km upstream from the Weyerhaeuser mill site and six were taken downstream on the mainstem of the Wapiti River (Fig. 1). Carcasses were sexed, weighed and measured. Livers and kidneys were removed, weighed and preserved in liquid nitrogen in the field. Digestive tracts were also removed and frozen. Attempts to collect quantities of bile from the birds were not successful. Carcasses and digestive tracts were stored at the Canadian Wildlife Service (CWS) in Saskatoon. Liver and kidney samples were shipped to the CWS, National Wildlife Research Centre in Hull for tissue preparation and archiving. Collection techniques and meristics of birds are summarized by Court (1992).

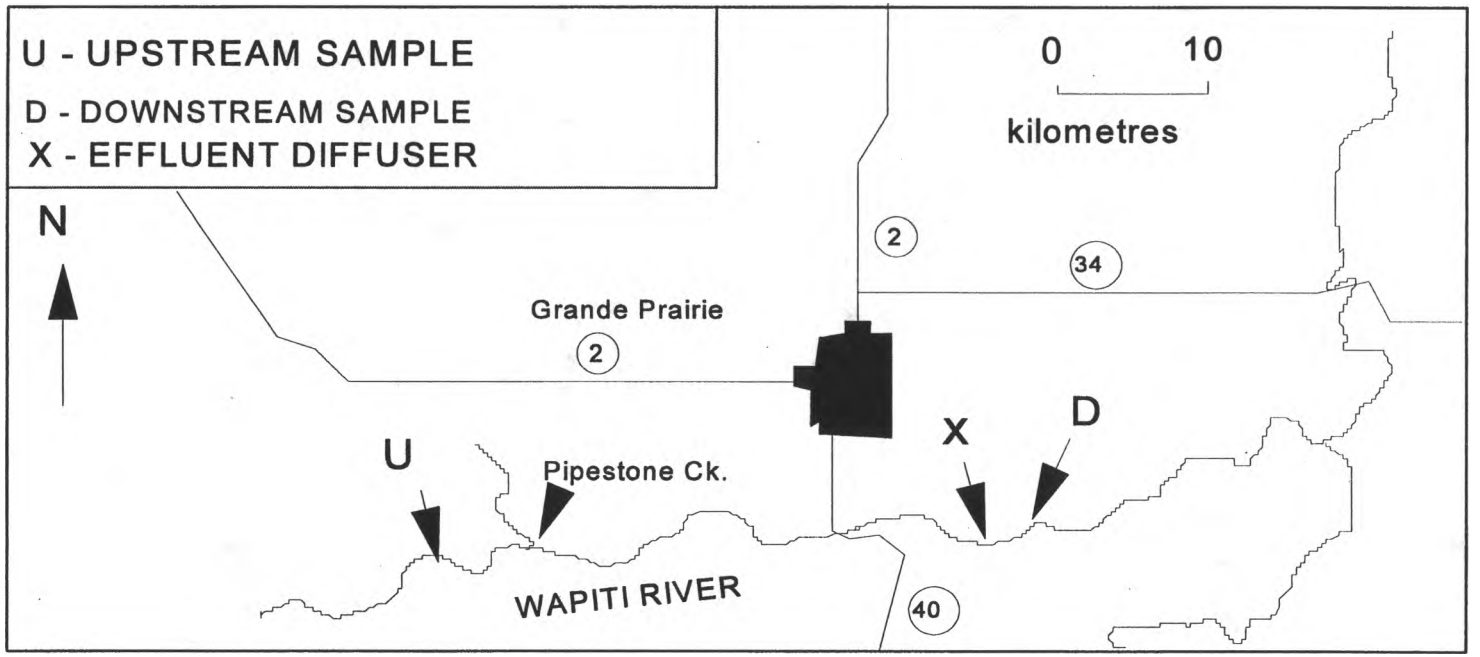


Fig. 1. Collection sites for Common Mergansers on the Wapiti River (Site U - Specimens 1 to 4 and Site D - Specimens 5 to 12)

Vitamin A as retinol and retinyl palmitate was determined at the CWS in Hull according to Catagani *et al.* (1983) and Furr (1990). Other biomarkers such as ethoxyresorufin-o-deethylase (EROD) were not determined because the amount of time between killing the birds and putting the organs in liquid nitrogen was too long (up to 1 hour) for such analyses to provide meaningful information.

Individual livers were homogenized and portions of individual liver homogenates were sent from NWRC to contract labs for PCB, organochlorine and metals analyses. Remaining portions of liver homogenates were pooled into single samples representing upstream and downstream collections and sent to contract labs for analysis of dioxin/furans and chlorinated phenolics. Individual kidney homogenates were used for cadmium analyses. Analytical procedures have been dealt with by contract labs and will not be further examined here.

3.0 RESULTS

Analyses were made for 25 dioxin/furan congeners or homologues, nine metals, 39 chlorinated phenolic compounds, 53 PCBs including three coplanar PCBs and 24 organochlorines (OCs). Residues of one furan, seven metals, three chlorinated phenolic, three PCBs and five OCs were detected. Table 1 lists the contaminants that were not detected in any of the pools.

Of the dioxins and furans, only 2378-tetrachlorodibenzofuran (TCDF) was detected. It was found in both the upstream and downstream pools and was over 2X higher in the downstream pool, suggesting a pulp mill effect (Fig. 2). Chlorinated phenolics were not detected in mergansers taken upstream from the mill but PCP, 2346+2356-tetrachlorophenol and 456-trichloroguaiacol were detected in mergansers from downstream, again suggesting a pulp mill effect (Fig. 3). Levels of PCBs and OCs were extrememly low; these compounds did not differ between upstream and downstream samples as indicated by the wide overlap in their ranges (Fig. 4). Metal levels were also low and exhibited a wide overlap in their ranges between upstream and downstream mergansers (Fig. 5).

Retinol appeared to be slightly lower in downstream birds than in upstream birds (Table 2). However, the same was not true of retinyl palmitate.

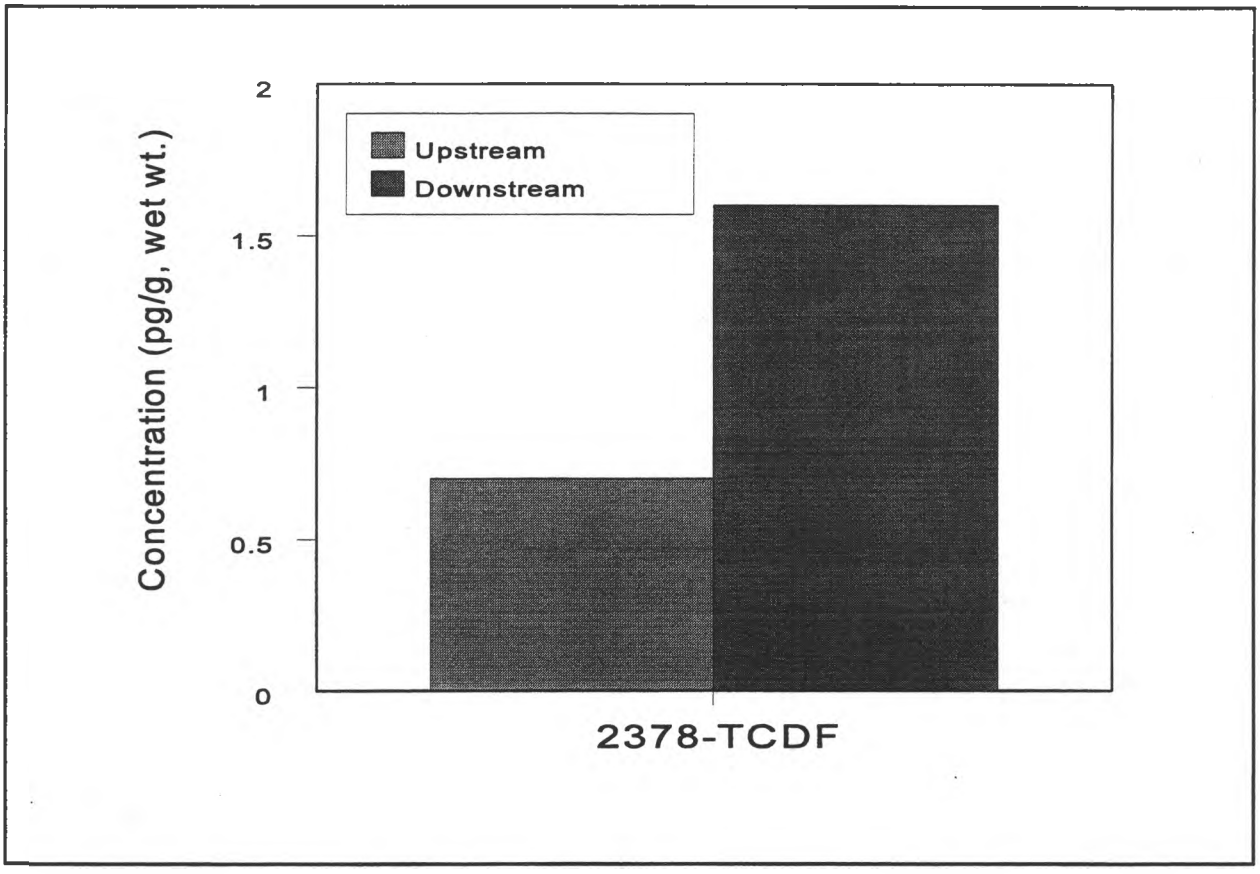


Fig. 2. 2378-TCDF levels in pooled Common Merganser liver homogenates (n=1) upstream and downstream from the Weyerhaeuser mill on the Wapiti River.

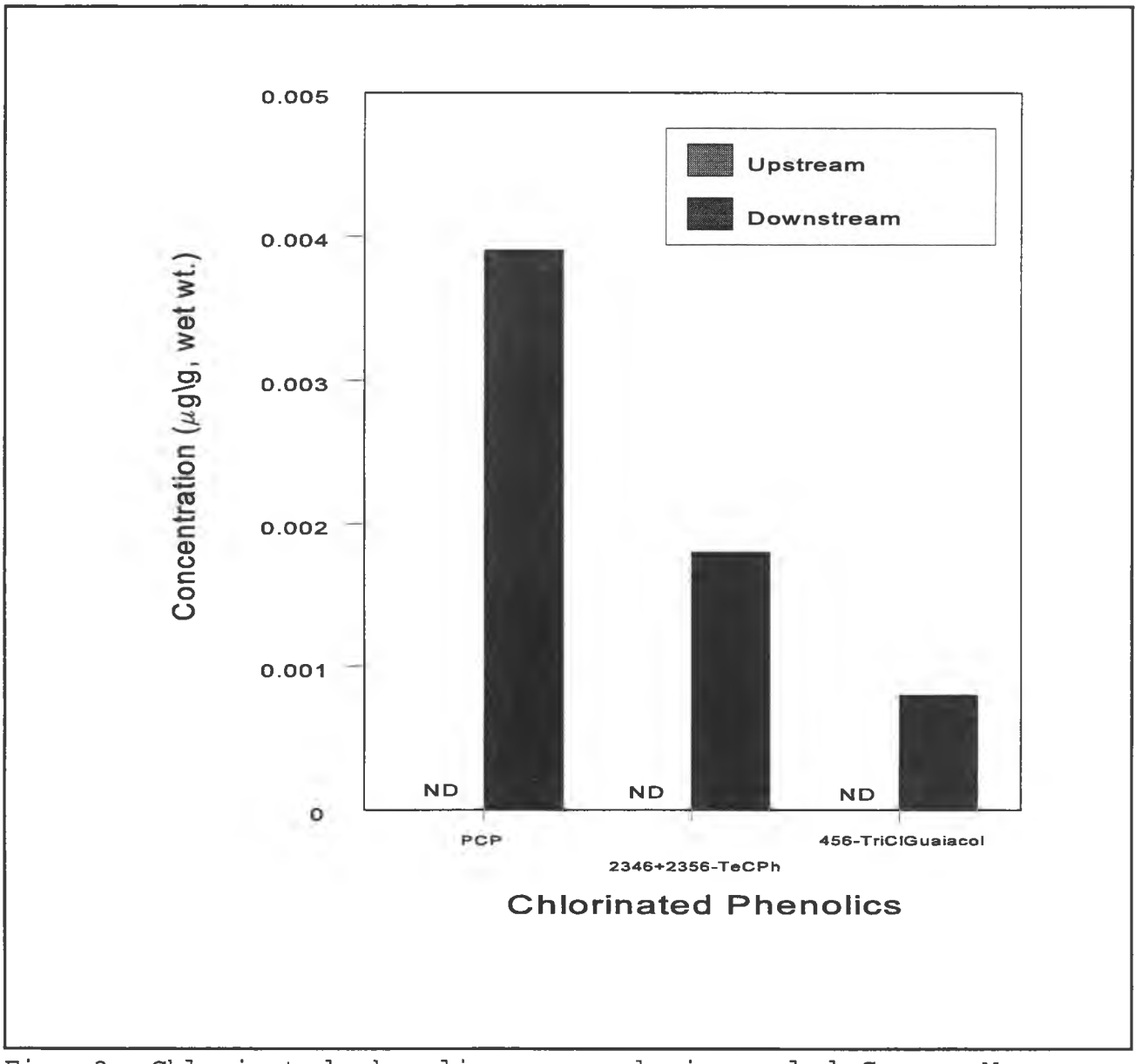
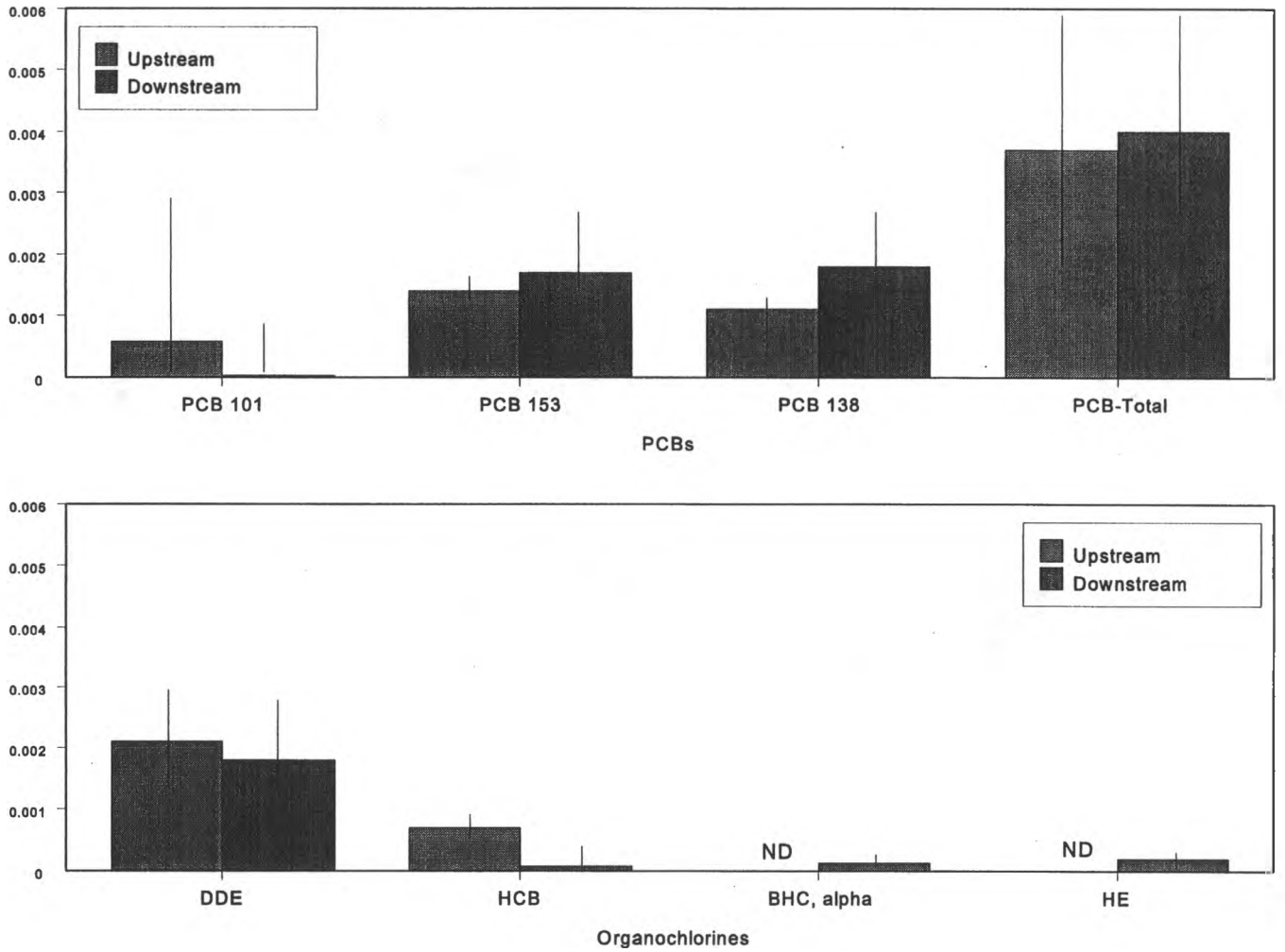


Fig. 3. Chlorinated phenolic compounds in pooled Common Merganser liver homogenates (n=1) upstream and downstream from the Weyerhaeuser (formerly P&G) mill on the Wapiti River.



ganochlorines (mean±range) in immature Common Merganser livers upstream (n=4) 5) from the Weyerhaeuser (formerly P&G) mill on the Wapiti River.

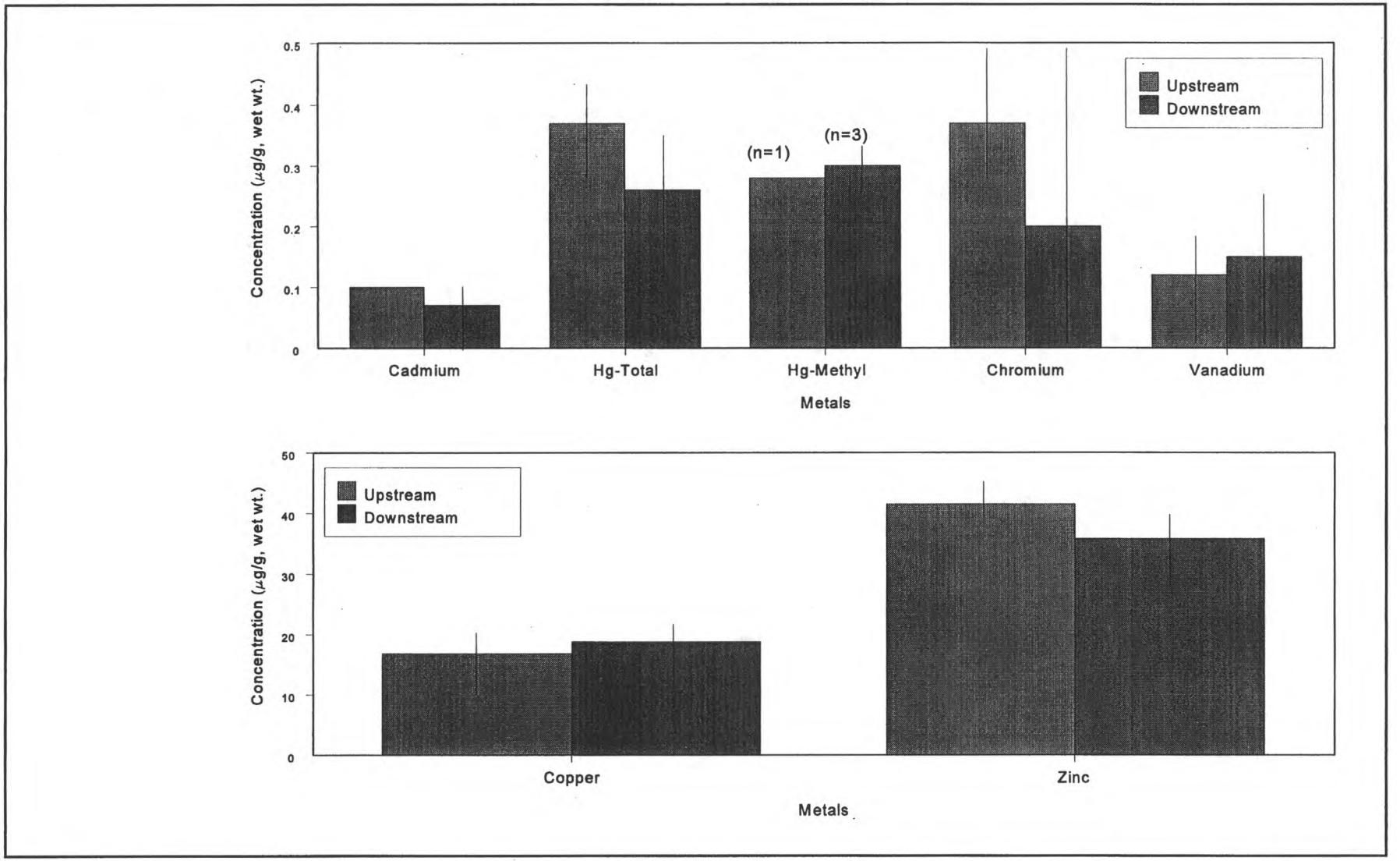


Fig. 5. Metals (mean ±range) in immature Common Merganser livers upstream (n=4) and downstream (n=6) from the Weyerhaeuser (formerly P&G) mill on the Wapiti River.

Table 1: Contaminants that were below detection limits in all samples of pre-fledged Common Mergansers.

Contaminiant Group				
Dioxins/ Furans [a]	Chlorinated Phenolics [b]	PCBs [c]	OCs [d]	Metals [e]
2378-TCDD	2345TeCP(henol)	5/8	Aldrin	As
12378PCDD	234TriCP		BHC, alpha	Pb
123478HxCDD	235TriCP	15	BHC, delta	
123678HxCDD	236TriCP	16/32	Chlordane, alpha	
123789HxCDD	45TriCP	31	Chlordane, gamma	
1234678HpCDD	246TriCP	28	DDD	
OCDD	24DCP	33	DDT	
12378PCDF	26DCP	22	Dieldrin	
23478PCDD	TCG(uaiacol)	52	Endosulfan I	
123478HxCDF	345TriCG	49	Endosulfan II	
123678HxCDF	346TriCG	44	Endrin	
234678HxCDF	45DiCG	40	Heptachlor	
123789HxCDF	46DiCG	70/76	Lindane	
1234678HpCDF	4CG	65/95	Methoxychlor	
1234789HpCDF	TeCC(atechol)	56/60	Mirex	
OCDF	345TriCC	84	Nonachlor, trans	
TCDD (non-2378)	34DiCC	89	Toxaphene	
PCDD (non-2378)	35DiCC	87		
HxCDD (non-2378)	45DCC	85		
HpCDD (non-2378)	4CC	110		
TCDF (non-2378)	TeCV(eratrole)	151		
PCDF (non-2378)	345TriCV	149		
HxCDF (non-2378)	45DiCV	118		
HpCDF (non-2378)	236TriCA	146		
	245TriCA	105		
	246TriCA	141		
	24DiCA	137		
	26DiCA	138		

Contaminiant Group				
Dioxins/ Furans [a]	Chlorinated Phenolics [b]	PCBs [c]	OCs [d]	Metals [e]
		129		
		182/187		
		183		
		128		
		185		
		174		
		177		
		171/202		
		180		
		191		
		170		
		201		
		196/203		
		189		
		195/208		
		207		
		194		
		205		
		206		
		209		
		77		
		126		
		169		

a detection limits as follows: 0.1 pg/g for 12378-PeCDD, 123478-HxCDD, 123678-HxCDD, 123789-HxCDD, 12378-PeCDF, 23478-PeCDF,123478-HxCDF, 123678-HXCDF, 0.2 pg/g for 2378-TCDD,1234678-HpCDD, 234678-HxCDF, 123789-HxCDF, 1234678-HpCDF; 0.3 pg/g for 1234789-HpCDF; 1.5 pg/g for OCDD and OCDF.

b detection limits are 0.0002 μg/g for 2345TeCP, 234TriCP, 235TriCp, 236TriCP, 245TriCP, 246TriCP, 24DiCP, 26DiCP and PeCA; and 0.0004 μg/g for the other chlorinated phenolics listed in the Table.

c detection limits for PCB congeners ranged from 0.00002 - 0.00005 μg/g for ortho-substituted congeners and 0.001 μg/g for non-ortho substituted congeners.

d detection limits range from 0.0002 - 0.001 μg/g for all Ocs except toxaphene for which the detection limit was 0.05 μg/g.

e detection limit 0.2 μg/g.

Table 2: Vitamin A levels (μg/g, mean ±1SD) in pre-fledged Common Mergansers upstream (n=4) and downstream (n=6) from the Weyerhaeuser Canada pulp mill on the Wapiti River.

	Sample Location	
Parameter	Upstream	Downstream
Retinol	15.1±8.9	5.7±2.3
Retinyl Palmitate	104.7±25.6	76.2±14.4

4.0 DISCUSSION

Levels of contaminants in the mergansers were low when compared to studies of other bird species in other locations (e.g Elliott *et al.* 1989, Environment Canada 1991). However, other studies have concentrated mainly on eggs or adult birds in contrast to this study which focused on pre-fledged birds. Pre-fledged mergansers had not yet had time to accumulate significant body burdens of contaminants and also, because of their rapid growth, had 'diluted' contaminant concentrations in their tissues. By way of illustration, Common Merganser eggs from the St. Maurice River in Quebec contained dioxin and furan levels that were 10X to 20X higher than in pre-fledged birds from the same area (L. Champoux, CWS, Quebec Region). In that study, dioxins and furans were higher than on the Wapiti river; for example, 2378-TCDF averaged 21 pg/g, over 10X the levels seen in the downstream mergansers. 2378-TCDD was detected in the Quebec study, at 2.5 pg/g, whereas it was not detected from mergansers on the Wapiti River. Forster's terns (*Sterna forsteri*) and Common terns (*S. hirundo*) between 15 and 20 days old from Green Bay, Lake Michigan averaged about 3 pg/g 2378-TCDD on a whole body wet weight basis (Ankley et al. 1993), whereas in this study, 2378-TCDD was below 0.2 pg/g in merganser livers. 2378-TCDF was generally below 1 pg/g in that study, whereas it was 1.6 pg/g in the pooled downstream liver homogenate in this study. In the Michigan study, total PCBs were greater than 3500 ng/g, nearly 600X higher than the highest recorded total PCB level in this study.

The Vitamin A levels appeared to be lower in the downstream mergansers than in the upstream ones. These results contrast with a Quebec study which showed no effect of exposure to pulp mill contaminants on vitamin A levels in mergansers, despite an almost 10X higher exposure of the Quebec mergansers to 2378-TCDF. It is possible that other factors, such as dietary or developmental differences, may have accounted for the differences in vitamin A. Alternatively, it is possible that metabolism of hepatic Vitamin A is related to the activity of certain MFO enzymes (Peakall 1992). If this is the case, a pulp mill effluent-mediated induction of EROD may affect vitamin A levels independently of exposure to dioxins and furans in the mill effluent. In the future, it may be worthwhile to examine retinoid metabolism in pulp mill effluent-exposed and non-exposed animals particulary at mills where dioxin and furan levels are low or non-detectable.

5.0 REFERENCES

Ankley, G.T., Niemi, G.J., Lodge, K.B., Halett, J.H., Beaver, D.L., Tillitt, D.E., Schwartz, T.R., Giesy, J.P., Jones, P.D. and Hagley, C. 1993. Uptake of planar polychlorinated biphenyls and 2, 3, 7, 8-substituted polychlorinated dibenzofurans and dibenzo-p-dioxins by birds nesting in the lower Fox River and Green Bay, Wisconsin, USA. March. Environ. Contam. Toxicol. 24:332-344.

Catignani, G.H., Drishell, W.J., Bashor, M.M., Turley, C.B. and Brewster, M.A. 1983. Simultaneous determination of retinol and α-tocopherol in serum or plasma by liquid chromatography. Clini. Chem. 29:708-712.

Court, G. 1992. Collection of young-of-the-year mergansers for environmental contaminant analysis. Prepared for the Northern River Basins Study by D.A. Westworth & Associates, Edmonton. Report No. 4.

Elliott, J.E., Butler, R.W., Norstrom, R.J. and Whitehead, P.E. 1989. Environmental contaminants and reproductive success of Great Blue Herons *Ardea herodias* in British Columbia, 1986-87. Environ. Pollut. 59:91-114.

Furr, 1990. Reversed-phase high performance liquid chromatography of retinyl esters. Methods in Enzymology. 189:85-94.

Government of Canada. 1991. Toxic chemicals in the Great Lakes and associated effects. Vol.1. Contaminant levels and trends. Environment Canada, Dep't. of Fisheries and Oceans, Health and Welfare Canada.

Peakall, D. 1992. Animal biomarkers as pollutioin indicators. Chapman and Hall Ecotoxicology Series, London.

Stelfox, H. 1977. Waterfowl food ecology and habitat use in northeastern Saskatchewan. M.Sc. Thesis, University of Saskatchewan, Saskatoon.

Timken, R.L. and Anderson, B.W. 1969. Food habits of common mergansers in the northcentral United States. J. Wildl. Manage. 33:87-91.

Vermeer, K., Armstrong, F.A.J. and Hatch, D.R.M. 1973. Mercury in aquatic birds at Clay Lake, western Ontario. J. Wildl. Manage. 37:58-61.

White, H.C. 1936. The food of kingfishers and mergansers on the Margaree River, Nova Scotia. J. Biol. Bd. Can. 2:299-309.

APPENDIX A: TERMS OF REFERENCE

No contractual Terms of Reference were prepared for the work documented in this report. The work was undertaken by the author as a contribution in kind from his employing agency and represents a part of his reponsibilities to the working committee of the Contaminants Component of the Northern River Basins Study.