January 6, 1994

Charles E. Findley
Director, Water Division
U.S. Environmental Protection Agency
1200 Sixth Avenue
Seattle, WA 98101

Dear Mr. Findley:

Attached is the U.S. Fish and Wildlife Service's biological opinion for formal consultation pursuant to Section 7(a)(2) of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq). At issue are the effects of concentrations of 2,3,7,8- tetrachlorodibenzo-p-dioxin, to be attained through implementation of a total maximum daily load, on bald eagles (*Haliaeetus leucocephalus*) along the Columbia River.

We have revised the second draft opinion submitted to you on September 21, 1993 based on comments and discussions with members of your staff. If you have questions or comments regarding the attached biological opinion, please contact Carol Schuler or Gary Miller at (503) 231-6179. We wish to thank you and your staff for working with us during this consultation process. We look forward to continued cooperation with you regarding future proposed actions.

Sincerely,

Russell D. Peterson
State Supervisor

Enclosure

cc: ES-Chief, Division of Environmental Contaminants
ES-Chief, Division of Endangered Species, Recovery and Consultation

January 6, 1994

In Reply Refer to: 1-7-92-F-619

Charles E. Findley
Director, Water Division
U.S. Environmental Protection Agency
1200 Sixth Avenue
Seattle, Washington 98101

Subject: Biological opinion on the effects of concentrations of 2,3,7,8-tetrachlorodibenzo-p-dioxin, to be attained through implementation of a total maximum daily load, on bald eagles along the Columbia River.

Dear Mr. Findley:

This letter is being issued in response to the U.S. Environmental Protection Agency (EPA), Region 10 Water Division's February 5, 1992, request for formal consultation with the U.S. Fish and Wildlife Service (Service) pursuant to Section 7(a)(2) of the Endangered Species Act of 1973, 16 U.S.C. 1531 et seq. (Act). Due to requests for additional information, formal consultation was not initiated until August 27, 1992. At issue are whether concentrations of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) to be attained through implementation of a total maximum daily load (TMDL) will adversely affect bald eagles (*Haliaeetus leucocephalus*) along the Columbia River. The bald eagle is federally classified as threatened within the States of Oregon and Washington.

I. CONSULTATION HISTORY

Informal consultation concerning establishment of a TMDL for TCDD was requested by the EPA in a letter dated October 17, 1990. The action indicated in this letter was issuing a National Pollutant Discharge Elimination System (NPDES) permit to the Potlatch Corporation for discharge of pulp mill effluent (containing TCDD) into the Lower Snake River System. The Service reply indicated that there was a paucity of information concerning dioxin accumulation and the potential effects of dioxin accumulation in fish and wildlife, and expressed concern over potential adverse effects of dioxin to threatened and endangered species along the Columbia River. The EPA was encouraged to participate in the Service's examination of dioxin levels in fish and wildlife along the Lower Columbia River, and later agreed to conduct analyses of biological material provided by the Service's Oregon State Office. Informal consultation and correspondence continued until a request for formal consultation was received, dated February 5, 1992. The Service replied by letter on February 11, 1992, and requested that the EPA keep the current TMDL in place pending completion of formal consultation, and that formal consultation be initiated following receipt of new information obtained by the EPA. The EPA was provided with a threatened and endangered species list by the Service on March 7, 1992. Following submittal of preliminary information by the EPA, dated April 2, 1992, the Service concluded that sufficient information was not present and requested further specific information be

provided by the EPA before formal consultation could begin (letter dated May 21, 1992). The requested information was provided by letter dated August 27, 1992, and formal consultation was initiated. Subsequently, the Service requested time extensions on December 3, 1992 (60-day), January 21, 1993 (until April 30, 1993) and April 26, 1993, (until May 10, 1993). A draft opinion was submitted to the EPA on May 10, 1993, and comments were received between July 1 and August 27, 1993. A revised draft opinion was submitted to EPA on September 21, 1993 and comments were received on October 5 and October 28, 1993. A final opinion was completed on November 12, 1993; however, EPA requested, on November 12 and 22, 1993, that the final opinion not be submitted until both agencies to could meet and further discuss the opinion. EPA and the Service met on January 4, 1994 to discuss revisions to the opinion.

This Biological Opinion was prepared using the following: (1) the TMDL for TCDD prepared by the EPA (February 25, 1991); (2) information provided in correspondence with the EPA on April 2, and August 27, 1992; (3) information resulting from the Service's evaluation of proposed dioxin criteria (August 17-19, 1992); and (4) file information and reference material located at the Service's Oregon State Office. During the course of our review other individuals were contacted who had special knowledge or expertise concerning the proposed project or the bald eagle. These include:

David Anderson, Washington Department of Wildlife
Robert Anthony, U.S. Fish and Wildlife Service, Oregon Cooperative Wildlife Research Unit
Steve Bradbury, U.S. Environmental Protection Agency, Environmental Research and Development
Phil Cook, U.S. Environmental Protection Agency, Environmental Research and Development
Geoff Dorsey, U.S. Army Corps of Engineers, Portland District
John Gabrielson, U.S. Environmental Protection Agency, Water Quality Division
Mary Gessner, U.S. Fish and Wildlife Service, Division of Environmental Contaminants, Washington, D.C.
Steve Forest, Sierra Club Legal Defense Fund
Charles Henny, U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Pacific Northwest Field Station
Chris Holm, Northwest Pulp and Paper Association
Frank Issacs, Oregon State University
Timothy Kubiak, U.S. Fish and Wildlife Service, East Lansing Field Office
Mary O'Brien, Dioxin/Organochlorine Center
Don Steffeck, U.S. Fish and Wildlife Service, Region 1 Regional Office
Ken Stromborg, U.S. Fish and Wildlife Service, Green Bay Field Office
Don Tillitt, U.S. Fish and Wildlife Service, National Contaminant Fisheries Research Center
Donald White, U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Southeast Research Station
Stanley Wiemeyer, U.S. Fish and Wildlife Service, Reno Field Office
Bill Williams, Ecological Planning and Toxicology

II. BIOLOGICAL OPINION

It is the Service's biological opinion that establishment of a total maximum daily load for 2,3,7,8-tetrachlorodibenzo-p-dioxin, not to exceed a surface water concentration of 0.013 picograms per liter (pg/l) at mean harmonic flow is not likely to jeopardize the

continued existence of the bald eagle. This action will not jeopardize the bald eagle because the scope of the action indicates that take associated with the project would not preclude recovery or appreciably reduce the chances of survival of the Oregon and Washington subpopulation of bald eagles. Critical habitat has not been designated or proposed for this species; therefore, none will be destroyed or adversely modified.

III. DESCRIPTION OF THE ACTION

The action is the establishment of a TMDL for TCDD in the Columbia River. The TMDL was established on February 25, 1991, and applies to all portions of the Columbia River from the United States-Canada border to the confluence of the river with the Pacific Ocean (U.S. Environmental Protection Agency 1991). The TMDL was designed to attain concentrations of dioxin in the river and its tributaries that do not exceed a water concentration of 0.013 pg/l at harmonic mean flow.

The TMDL was developed because the water quality of the Columbia River and segments of the Snake and Willamette Rivers was considered impaired due to elevated concentrations of TCDD (U.S. Environmental Protection Agency 1991). Concentrations of TCDD measured in fish tissues collected from the Columbia River exceeded guidelines for the protection of human health. The Clean Water Act (Section 303[d]) requires States to identify waters for which effluent limitations are not stringent enough to attain water quality standards and to establish TMDLs for these waters. The States of Oregon, Washington, and Idaho requested that the EPA establish the TMDL.

Basically, the TMDL is the amount of loading that the river can receive without violating water quality standards. The TMDL is calculated by allocation of allowable loads to point sources, nonpoint sources, background, and a margin of safety. A margin of safety is used to account for any lack of knowledge about pollution sources and potential effects on water quality. The background is the load of pollutants already in the system from previous discharges. Several sources of dioxin were identified that contribute to the load of TCDD in the river, including bleach-kraft pulp mills, municipal wastewater treatment facilities, wood treatment facilities, agricultural areas, industrial sites, and urban areas.

IV. SPECIES ACCOUNT/ENVIRONMENTAL BASELINE

The bald eagle is an endemic North American species and the sole member of the fish or sea eagles in North America (U.S. Fish and Wildlife Service 1986). Two races of the bald eagle are currently recognized, a larger northern race and the smaller southern race; increasing size is exhibited gradually from south to north (Stalmaster 1987). Little information exists on longevity in the wild. Longevity of captive eagles ranges from 15 to 47 years, with an estimated reproductive life of 20 to 30 years (Stalmaster 1987). Bald eagles reach sexual maturity at 5 years of age (average), following the fourth molt to adult plumage (Stalmaster 1987). Sexual dimorphism is expressed in bald eagles by size differences between sexes; females are larger and weigh on average 5.3 kg versus 4.5 kg average weight for males. Pair bonds between breeding adults are believed to last over the life of the bird. Once sexually mature, eagles may exhibit considerable reproductive variation, likely in response to quality and quantity of food resources, although other factors such as human disturbance may preclude or interrupt nesting. Timing and duration of nesting and breeding activities varies with latitude. Southern populations may begin reproductive activity as early as October, with young fledging by March or April (Beebe 1974, Stalmaster 1987). According to Beebe (1974), eagles breeding in the proximity of the Mackenzie Delta arrive on their breeding territories in late April, with young fledging in August. In Oregon and Washington, the breeding season may extend from January through August (Garrett et al. 1988). Bald eagles may maintain more than one nest within a given breeding territory. The reasons for multiple nests are not always apparent, and include: providing an alternative nest location in case of physical nest or nest tree failure, alternate use of nests to reduce nest parasite loads; nest building or repair may be a behavioral precursor to reproduction (Stalmaster 1987, Garrett et al. 1988). Nests are usually constructed in the dominant or codominant trees within a territory that commands a clear view of the terrain and a clear flight path to their feeding areas (Garrett et al. 1988). Average developmental time periods include: 1) 35 days for incubation; 2) approximately 2 days to hatch; 3) hatchlings are able to thermoregulate in 2 weeks; and 4) fledging requires 11 weeks (Stalmaster 1987, Issacs et al. 1983). Clutch sizes range from one to three eggs. Successful pairs usually raise one or two, or occasionally three, young per nesting attempt. Juvenile development in bald eagles proceeds rapidly. The average weight of nestling increases from approximately 100 grams to

4,000 or 5,000 grams over a three month period (Stalmaster 1987). After fledging, young may remain in the area for an indefinite period of time. Bald eagles are opportunistic feeders, and their food habits may vary with location, relative prey abundance, age, and seasonally (Stalmaster 1987, Garrett et al. 1988). General food preference includes: fish 50 to 90 percent, birds (mainly waterfowl and fish-eating birds) 7 to 28 percent, and mammals 3 to 14 percent (Stalmaster 1987, Garrett et al. 1988, Watson et al. 1991). According to Beebe (1974), bald eagles engage in the most complex post-breeding migratory movements of any North American raptor. In coastal areas, due to mild climatic conditions and year-round prey availability, eagles are present year long (Beebe 1974). During winter, populations of bald eagles may consist of resident breeding and non-breeding adults, and migrating juveniles and adults (Stalmaster 1987, McGarrigal et al. 1991). Stalmaster (1987) states that the ratio of winter migrants to resident breeding pairs (in the contiguous states) may be as high as 10 to 1.

The bald eagle is Federally listed as endangered in 43 of the 48 conterminous States. Populations in the Pacific Northwest (Oregon and Washington) are listed as threatened. Historically, declining bald eagle populations prompting listing of the species, were attributed to several factors including: acute and chronic toxic affects resulting from environmental contaminants; destruction of nesting, wintering, and foraging habitat; electrocution; and illegal persecution and disturbance. In general, for an action to be considered to jeopardize a listed species, the effects of the proposed action and associated cumulative effects would have to be sufficient to jeopardize the "continued existence" of the entire species, subspecies or population as listed. Also considered are actions which may significantly impair recovery of a listed species, or involve other adverse effects which may jeopardize the continued existence of a listed species. A memorandum issued March 3, 1986, by the associate director of the Service concerning application of jeopardy standards, identified a procedure to define exceptions to the general policy, and identified 8 groups of species qualifying for exception, that included bald eagles. Bald eagle populations which qualify for separate consideration under section 7 include:

a. Chesapeake Bay population
b. Southeast population
c. Northern States population
d. Pacific population
e. Southwest population

The endangered and threatened populations can be further subdivided within areas c and d. This distinguishes threatened bald eagle populations in Oregon and Washington as the minimum population for assessing actions that are likely to jeopardize the species continued existence, or present a significant impairment to recovery efforts.

The Pacific States Bald Eagle Recovery Plan lists four criteria for delisting in the 7-State recovery area: 1) a minimum of 800 nesting pairs in the Pacific recovery area; 2) a 5-year average reproductive rate of 1.0 fledged young per pair; 3) attainment of breeding population goals in at least 80 percent of the management zones with nesting potential; and 4) stable or increasing wintering populations. The Implementation Plan outlines the following goals for Washington and Oregon: 1) restore the population of nesting bald eagles to 482 nesting pairs in the 2 states; 2) maintain a 5-year average fledging success of 1.0 young per occupied site and average nesting success of 65 percent; 3) maintain winter habitat sufficient to support a population of wintering bald eagles equal to or greater than the current population; and 4) educate the public about bald eagles and their habitat needs. The recovery population goal for Oregon is 206 nesting pairs (occupied sites). Recovery zones that encompass portions of the Columbia River include: 1) the Cascade Mountains (zone 6); 2) the Upper Columbia Basin (zone 7); 3) the Palouse Prairie (zone 8) in Washington; and 4) the Lower Columbia River recovery zone extends from the confluence of the Columbia and Snake Rivers in central Washington to the terminus of the Columbia River at the Pacific Ocean. The combined Oregon and Washington Recovery Plan goal for the subpopulation of bald eagles occupying the Lower Columbia River zone is 31 territories.

Figure 1. Bald eagle young produced per occupied territory (territories with known outcome) from 1980 to 1992 for Oregon, Washington, and the Columbia River Recovery Zone (zone 10). Statewide data include values for the Columbia River Recovery Zone.

Within the Lower Columbia River Recovery Zone, eagle numbers fluctuate as resident populations are augmented by migrating eagles, primarily during the winter and early spring (Garrett et al. 1988). Depending on the season, populations of bald eagles along the Columbia River may include resident adults and juveniles, and juvenile and adult migrants. Nesting and productivity data apply solely to resident breeding pairs, since migrating eagles will breed in other locations, or are not sexually mature. Figure 1 displays annual productivity information for Oregon, Washington, and the Lower Columbia River (zone 10). Data are contained in various documents produced by the Bald Eagle Working Team for Oregon and Washington, or were obtained directly from members.

As depicted in Figure 1, eagle productivity in the Lower Columbia River Recovery Zone exhibits considerable fluctuation, and has consistently remained below statewide levels in both Oregon and Washington. Further productivity differences exist within the Lower Columbia between Oregon and Washington. In some years, extreme differences have been observed between the Oregon and Washington sides of the Columbia River. For example, in 1991 the Oregon side of the Columbia River produced 1.07 young per occupied nest site, while the Washington side produced 0.14 young per occupied site. Both states have experienced years where no young were produced, 1980 in Oregon and 1980 and 1982 in Washington. The number of years with productivity below 0.50 young per occupied territory (1980-1992) are 4 in Oregon and 7 in Washington. The mean productivity from 1980-1992 is 0.61 for Oregon and 0.40 for Washington.

Available 1992 data for the State of Oregon indicates 205 out of 227 bald eagle sites (90 percent) were occupied by bald eagles. The 1992 average productivity for the State of Oregon was 0.97 young per occupied site, with a 5-year average productivity rate of 0.92 young per occupied site. Washington State 1992 data indicate that 461 breeding territories were occupied with 0.97 young produced per occupied territory, and a 5-year average productivity of 0.98 young per occupied territory. In the Lower Columbia River Recovery Zone, the total number of bald eagle sites was 37 in

1992, i.e. 19 territories in Oregon and 18 territories in Washington. Of the 37 surveyed territories 35 were occupied and 18 (52 percent) were occupied successfully. Four sites in Oregon and one site in Washington were newly discovered in 1992. The 5-year productivity average (1988-1992) for the Lower Columbia Recovery Zone is 0.55 young per occupied territory. Comparisons of available information for the 5-year average productivity between Oregon and Washington States and the Lower Columbia River Recovery Zone are presented in Figure 2. A 5-year average reproductive rate of 1.0 fledged young per occupied site with maintenance of an average success rate of not less than 65 percent (i.e. 65 percent of surveyed territories are occupied) are recovery goals for bald eagles in the Pacific Recovery Area. Since annual fluctuations are expected in bald eagle populations, the 5-year average provides a more representative trend to evaluate reproductive success over time. Average success rates for the Lower Columbia River are substantially lower than rates observed for other nesting areas in Oregon and Washington.

Figure 2. 5-year average productivity (young produced/occupied territory where outcome was known) for Oregon, Washington, and the Columbia River Recovery Zone (zone 10) from 1984 to 1992. Statewide data include values for the Columbia River Recovery Zone.

The 1990 Midwinter bald eagle count for the State of Oregon was 701 bald eagles, an increase of 42 percent over the 1989 count. Statewide data for Washington was not available during this consultation. In Recovery Zone 10, the mid-winter 5-year average from 1979 to 1983 was 47.6 bald eagles. The mid-winter 5-year average from 1988 to 1992 was 97.0 bald eagles. Winter populations of bald eagles along the Lower Columbia River include resident adults, resident subadults, and migrants. No attempt was made to adjust for differences in weather, observers, routes, or number of routes in mid-winter counts.

Although food availability may influence winter site tenacity in other locations, observation of resident eagles on the Lower Columbia River suggests year-round site fidelity (Watson et al. 1991). Foraging behavior of eagles along the Lower Columbia River have been documented in several studies (Garrett et al. 1988, Watson et al. 1991) and further substantiate their opportunistic feeding habits. Fish were the primary prey taken by bald eagles accounting for 71 percent of prey remains found in nests and 90 percent of direct foraging observations (Watson et al. 1986). Birds (primarily waterfowl and fish-eating birds) and mammals constituted 26 and 2 percent of nest remains and 7 and 3 percent of direct observations respectively. Garrett et al. (1988) and Watson et al. (1991) provide tabular summaries of identified prey remains and percent composition.

Contaminant Conditions

Bald eagles nesting along the Lower Columbia River have experienced low productivity since monitoring of reproductive success first began in the early 1980's (Figure 2). An investigation by Anthony et al. (1993) during 1985 and 1986 established a strong correlation between the poor reproductive success of the Columbia River eagle population and concentrations of DDE and total PCBs and eggshell thinning. High concentrations of DDE and PCBs in eggs and carcasses were associated with marked eggshell thinning and low reproductive success (Table 1). DDE has been shown to cause significant thinning of eggshells in wild populations of bald eagles (Hickey and Anderson 1968, Krantz et al. 1970, Anderson and Hickey 1972, Wiemeyer et al. 1972, Grier 1974).

Table 1. Eggshell thickness and concentrations (µg/g wet weight) of DDE and PCBs in fresh bald eagle eggs, Columbia River Estuary, 1985-87 (Anthony et al. 1993).

Eggshell measurement/ Contaminant	n	Mean	Range
Thickness (mm)	17	0.55	0.49 - 0.61
% change	17	-10	-19 - +5
p,p' DDE	17	9.7	4.0 - 20.0
PCBs	17	12.7	4.8 - 26.7

Although poor reproductive success in the Columbia River appears to be linked to DDE and total PCBs, it has not been determined whether polychlorinated dibenzo-p-dioxins (dioxin) or polychlorinated dibenzofurans (furan) in the system are also associated with population conditions. The study by Anthony et al. (1993) did not include residue analysis for dioxin. Two eggs collected from the Columbia River for his study in 1985/86 and two additional eggs (addled) collected in 1991 were analyzed for dioxins and furans. Results of these analyses indicate that nesting bald eagles are also accumulating dioxins [Table 2] (Anthony et al. 1993, U.S. Fish and Wildlife Service unpublished data). Concentrations in these eggs were substantially higher than concentrations (TCDD = 12.62 pg/g; total toxic equivalents = 28.73 pg/g) in 1985/86 eagle eggs collected outside of the Columbia River, on Gray's River in Washington (U.S. Fish and Wildlife Service, unpublished data). Further study will be needed to determine what affect these concentrations may have on reproductive success. However, the TCDD concentrations were similar to or greater than concentrations found in other studies that are showing reproductive effects. Kubiak et al. (1989) found impaired reproductive success in Forster's terns when median egg concentrations were 37.3 pg/g. In a field study with wood ducks, White et al. (1993) found reduced hatching success and duckling survival with TCDD concentrations of 21 pg/g. TCDD concentrations in Columbia River eagles are about half those found in great blue heron eggs that are believed to have caused reproductive failure in a Canadian colony located near a pulp mill (Bellward et al. 1990, Hart et al. 1991). Although evidence is not conclusive that TCDD is negatively affecting nesting bald eagles along the Columbia, concentrations in the eagle eggs indicate that the birds are accumulating concentrations that could potentially impair reproductive success.

Table 2. Concentration (pg/g wet weight) of TCDD and Toxicity Equivalents (TEQs) in addled bald eagle eggs, Columbia River, 1986-91 (Anthony et al. 1993; U.S. Fish and Wildlife Service unpublished data).

Site	2,3,7,8-TCDD	Total TEQs[1]
Gray's Point[2]	60.00	86.11[3]
Mayger	35.50	73.07[3]
Megler Point[2]	61.00	86.70[3]
Young's River	34.05	76.73[3]

[1] TEQs represent the toxic equivalents scaled to the same amount of TCDD. TEQs include TCDD and TCDF concentrations.

[2] Addled eggs collected in 1991.

[3] One-half of the analytical detection level was assigned to samples with no detectable residues.

Other fish-eating birds nesting in the Columbia River also appear to be accumulating concentrations of dioxins and furans [Table 3] (U.S. Fish and Wildlife Service unpublished data). TCDD concentrations were lower than those found in bald eagles, and double-crested cormorants had the greatest concentrations of the species examined. Some TCDD concentrations in double-crested cormorants were similar to concentrations found in studies by Kubiak et al. (1989) and White et al. (1993).

Table 3. Geometric means[1] and ranges of TCDD concentrations (pg/g wet weight) and TEQs in fish-eating bird eggs from the Columbia River, 1990-91 (U.S. Fish and Wildlife Service unpublished data).

Species	n	2,3,7,8-TCDD mean (range)	TEQs mean (range)
Bald Eagle	4	45.86 (34.05-61.0)	48.90 (37.92 - 62.72)
Double-Crested Cormorant	9	18.18 (3.6-49.0)	18.28[2] (12.03 - 49.0)
Western Gull	8	4.45 (0.73-23.6)	4.54[2] (0.79 - 23.69)
Caspian Tern	5	3.58 (2.9-6.0)	4.02[2] (3.16 - 6.2)

[1] One-half of the analytical detection level was assigned to samples with no detectable residues.

[2] TEQs computed with TCDF and TCDD only, analysis not completed for other dioxins and furans.

Bald eagles and other fish-eating birds are most likely exposed to dioxins and furans through their consumption of contaminated prey. Bald eagles nesting along the Columbia River are year-around residents and forage almost exclusively in the Columbia River (Garret et al. 1988). Consequently, the birds' TCDD exposure would emanate from the Columbia River. Chemical analyses of fish in the

Columbia River have also shown an accumulation of dioxins and furans (U.S. Fish and Wildlife Service unpublished data). The Service found TCDD concentrations in fish that ranged from 1 to 9 pg/g (geometric mean = 1.7 pg/g) and much higher concentrations of TCDF ranging from 5 to 83 pg/g (Table 4). EPA's (1992a) National Bioaccumulation study found similar TCDD concentrations in Columbia River fish ranging from 1 to 8 pg/g.

Table 4. Geometric means[1] and range of 2,3,7,8-TCDD concentrations (pg/g) and TEQs in fish from the Columbia River, 1990-91 (U.S. Fish and Wildlife Service unpublished data).

Species	n	2,3,7,8-TCDD mean (range)	TEQs[2] mean (range)
Common Carp	4	1.65 (<1.0 - 5.0)	2.82 (<1.0 - 6.7)
Northern Squawfish	5	2.70 (<1.0 - 9.0)	3.54 (<1.6 - 17.3)
Peamouth	11	1.80 (1.1 - 3.4)	4.44 (2.84 - 8.19)
Suckers	6	0.93 (0.55 - 1.94)	1.44 (0.93 - 2.95)

[1] One-half of the analytical detection level was assigned to samples with no detectable residues.
[2] TEQs computed with TCDF and TCDD only, analysis was not completed for other dioxins and furans. Toxicity equivalence factors were from Safe (1987).

Recent analytical results from eagle eggs indicates that Columbia River nesting eagles are accumulating DDE, PCBs, and dioxins. Studies with experimental and wild populations of bald eagles implicate DDE and PCBs as a cause for low productivity, but it is not as clear what role dioxin has played in producing present and historical population conditions. Research on the effects of dioxin in experimental and field studies with avian species is fairly new, but provides preliminary evidence that dioxins at levels observed in the Columbia River can affect the successful reproduction of some avian species.

No information is available on dioxin concentrations in non-resident, migrating eagles. These birds will also be exposed to dioxin when wintering and foraging in the Columbia River. However, what effect seasonal exposure will have on eagles is unknown.

V. <u>EFFECTS OF THE ACTION ON LISTED SPECIES</u>

To determine whether concentrations of TCDD to be attained through implementation of the TMDL would jeopardize the continued existence of bald eagles, requires an evaluation of the development of the TMDL, an examination of the contaminant load in eagles and other components of the ecosystem, and a determination of whether the TMDL concentration will be protective of bald eagles.

Total Maximum Daily Load

A review of the TMDL development indicates that several factors were not sufficiently developed or understood accurately to determine loading allocations that will meet the established TMDL concentration. Although EPA used the best available information to allocate TCDD loads to sources in the Columbia River Basin, determinations were based on many unknowns and several assumptions. These unknowns could lead to exceedence of the TMDL and to conditions potentially hazardous to nesting bald eagles. Parameters not clearly understood are associated with non-permitted or unregulatable discharges of TCDD. The following paragraphs are an evaluation of these poorly understood parameters and some of the implications if these sources do not meet their allocated load.

The TMDL addresses only one dioxin congener, TCDD and does not consider other contaminants found in Columbia River, including DDE, PCBs, and other dioxin and furan congeners. Chemical analyses of Columbia River samples have documented the accumulation of these contaminants (Anthony et al. 1993, U.S. Environmental Protection Agency 1992a; U.S. Fish and Wildlife Service, unpublished data). Earlier studies have shown that DDE and PCBs have had a negative effect on reproductive success of bald eagles nesting along the Columbia River (Anthony et al. 1993). Although the TMDL does not account for the presence of these contaminants, they are an important consideration because eagles are not selectively exposed to only one contaminant.

Historically, the scientific community examined effects of contaminants on a single chemical basis. We have now learned that many chemicals can have additive or synergistic effects when combined. Thus, it is important to consider potential effects of other contaminants in the ecosystem to determine what will be protective of an endangered species. PCB, dioxin, and furan congeners have structural similarities and produce similar toxic and biologic effects. Complex mixtures of these contaminants could potentially have a greater effect than the effects of TCDD alone (Birnbaum et al. 1985). Sufficient information exists on the relative potency of these compounds to develop potency ratios or toxic equivalency factors (TEFs). The use of TEFs is well documented in the scientific community and is commonly used in investigations of dioxin effects, although there are some differences is calculated TEFs. TEFs for dioxin and furan congeners were developed by Safe (1987, 1990), and Barnes et al. (1991) developed TEFs for PCB congeners. TEFs are ratios of the potency of a specific compound to that of TCDD. 2,3,7,8-tetrachlorodibenzofuran (TCDF) has only a slightly lower potency than TCDD. Evaluation of toxic equivalents (TEQs) for Columbia River samples indicates that the largest contribution to concentrations were from TCDD (Tables 2, 3, 4). However, other congeners did substantially contribute to TEQ concentrations in avian samples. A consideration of all of the dioxin-like compounds should be included in the TMDL determination. Even though they may not be regulated as such, they are present in the ecosystem and will contribute to dioxin-like toxicity. At this time, it is believed by the scientific community that an additive model of potential toxicity is appropriate. If TEQs or some other consideration of additive effects is not used, then calculations of a TMDL must consider additional safety factors.

Pulp and paper mills are not the only source of dioxin in the Columbia River Basin. Other sources of dioxin include wood treatment facilities, municipal wastewater treatment plants, industrial sites, agricultural areas, and urban areas (U.S. Environmental Protection Agency 1991). However, little is known about the amount of dioxin released from these sources. Only limited information was available on two sources, wood treatment facilities and wastewater treatment plants. Using available information, EPA allocated 38 percent of the load (2.3 mg/day) to these two sources (U.S. Environmental Protection Agency 1991). Data analyses from EPA's (1992a) National bioaccumulation study gives some indication that fish downstream of wood treatment facilities are bioaccumulating TCDD. This provides further evidence that other sources of dioxin could be significant. Allocation of TCDD load to these two sources is based on limited data and no information is available to determine loads from other sources. Additional data is needed to determine the quantity of TCDD actually released from these sources. Until this data is obtained, it is necessary to allocate a greater load or margin of safety to these unmeasured sources.

Five percent of the TCDD loading capacity was allocated to Canadian sources (U.S. Environmental Protection Agency 1991). This amounts to approximately 0.31 mg/day. The only measured source of TCDD loading in Canada is for the Celgar Pulp Mill. This mill currently exceeds its allocated load, although the mill indicates it will be substantially lowering discharges by 1994. If this occurs the mill will meet the allocated load. However, the TMDL does not account for other sources of dioxin in Canada. Other mills are located on the Columbia River drainage and presumably other unidentified sources exist. It is possible that other sources will be covered under the amount allocated to Canada, but this is completely unknown. Consequently, a larger margin of safety may be needed to account for unknown and unregulatable discharges from Canadian sources.

Canada is proposing to substantially reduce discharges of dioxin to the Columbia River. Proposed reductions are from 0.31 mg/day to 0.05 mg/day. We believe it commendable that Canada is reducing their discharges. Since Canada is able to make these reductions, we question why the mills in the Columbia River Basin are unable to reduce their own discharges using similar technology.

Background TCDD concentrations were accounted for in the margin of safety. Background concentrations are amounts of TCDD now present in the Columbia River system. Past discharges or releases of TCDD can be retained in sediments and aquatic biological organisms. Chemical analyses indicate that some aquatic organisms currently have an elevated background concentration of TCDD (Anthony et al. 1993, U.S. Fish and Wildlife Service unpublished data, U.S. Environmental Protection Agency 1992a). 'Background' concentrations need to be given full consideration when calculating allocated loads. As dioxin concentrations decline in the Columbia River system, dioxins retained in sediments can become a reservoir for TCDD (Baudo et al. 1990). Sediments will continue to release TCDD during storm events and dredging operations and as the system continues to equilibrate through leaching and resuspension (Baudo et al. 1990). Futher, as water column levels decline, existing sediment contamination may dominate the equilibrium process.

The margin of safety was used to cover contributions from unmeasured nonpoint sources, other industrial sources, background levels in sediments and biota, and possible future growth (U.S. Environmental Protection Agency 1991). This portion of the allocated load must also cover any inadequacies in allocated loads for pulp and paper mills, Canadian sources, wood treatment facilities, and municipal wastewater treatment plants. EPA reserved 22 percent of the allocated TCDD load to the margin of safety. Although this load may be sufficient to cover all unidentified and unmeasured contributions, it is based almost entirely on judgement and the amount of unallocated load. Additional data is needed to better estimate the margin of safety. Although we recognize that many sources of dioxin can not be measured, until better information becomes available we believe a larger margin of safety is needed to protect bald eagles.

Total Maximum Daily Load - No Effect Level

The EPA determined that an ambient water concentration of 0.013 pg/l would not adversely affect the continued existence of bald eagles (U.S. Environmental Protection Agency 1992b). This is based on a determination that bald eagles would not be adversely affected when exposed to a TCDD dose of less than 140 pg/kg of body weight/day (Bradbury 1992). Through development of a risk assessment model, EPA calculated that attainment of 0.013 pg/l would result in a dose of 130 pg/kg body weight/day. Thus, concluding that the establishment of the TMDL would be protective of bald eagles.

The EPA "no effect level" (NEL) for water (the TMDL) was derived from an equation using the following parameters: bald eagle weight, amount of drinking water consumed, amount of fish consumed, percentage of fat in the forage fish, inter- and intraspecies sensitivity factors, and a bioaccumulation factor from water to fish. The Service is concerned that this model is based on several assumptions that have not been clearly defined. Furthermore, it uses data that have not been sufficiently developed for the Columbia River and could substantially affect the outcome of this model. Additionally, the parameters in this model cannot be validated to determine if a NEL is being achieved in the Columbia River.

The equation used to calculate the EPA (Bradbury 1992, U.S. Environmental Protection Agency 1991) no effect level is as follows:

$$\text{No Effect Level (NEL)} = \frac{[\text{NOAEL x SSF}] \text{ x } Wt^{(eagle)}}{[\text{Water}] + [(1.0)(\text{Fish x BAF})]} \quad (\text{Intra-SSF})$$

Parameters used in the above equation are defined as follows:

No Effect Level: an ambient surface water concentration that would cause no adverse effects on bald eagle populations when exposed to a pollutant through their drinking water and food consumption [0.013 pg/l]

NOAEL: No Observable Adverse Effect Level - the highest concentration where no adverse effects were observed in laboratory studies by Nosek (1991) with ring-necked pheasants [14,000 pg/kg body weight/day]

SSF: Species Sensitivity Factor - to account for interspecies sensitivity [0.1]

$Wt_{(eagle)}$: Weight of an adult bald eagle [4.5 kg]

Water: Amount of water consumed by a bald eagle [0.16 l/day]

Fish: Amount of fish consumed by a bald eagle [0.50 kg/day]

BAF: Bioaccumulation Factor - ratio of TCDD in fish with a 9 percent fat content to that in water [90,000]

Intra-SSF: Intra-species sensitivity factor - to account for the sensitivity of individuals [10]

A variety of assumptions were used to define the above parameters and to arrive at a no effect level for bald eagles. It is important to consider the validity of each of these assumptions and explore where they may affect the model outcome. The following is a discussion of each of these parameters and some of our concerns.

NOAEL: The EPA used a NOAEL developed by Nosek in studies with ring-neck pheasants. In Nosek's (1991) studies, female pheasants were intraperitoneally dosed with TCDD once a week for ten weeks. They found no significant effects on egg hatchability, number of eggs produced, or embryo mortality at a dose of 14,000 pg/kg body weight/day; whereas significant effects were observed at a concentration of 140,000 pg/kg body weight/day. Thus, establishing a NOAEL for pheasants at 14,000 pg TCDD/kg body weight/day.

We must first consider the suitability of studies used to determine the NOAEL. Nosek's studies (1992a, 1992b, 1993) appear to be some of the most extensive laboratory studies on the effects of TCDD. EPA based their calculation of the NOAEL on the intraperitoneal dose injected into pen-reared pheasants. However, given differences in sensitivity between species, it is important to consider other studies. Chickens are generally believed to be the most sensitive laboratory species and some consideration should be given to studies with chickens. Further, Nosek's (1992a) NOAEL is not based on the most sensitive life stage but rather on the dose to the hen, not the resulting concentration in the egg. In another study, Nosek (1993) found that embryos were 11 to 19 times more sensitive than adults. In studies with chickens, researchers found that the embryo was 100 to 200 times more sensitive than the adult (Allred and Strange 1977, Grieg et al. 1973). Consequently, basing a NOAEL on an intraperitoneal dose to an adult may not provide sufficient protection for the most sensitive life stage, the developing embryo, due to differences in pharmacokinetics among species and routes of exposure.

Nosek (1992a, 1992b, 1993) and others (Allred and Strange 1977, Grieg et al. 1973) have demonstrated that the developing avian embryo is the most sensitive life stage to TCDD-induced toxicity. Therefore, the Service believes that the NOAEL should be based on a dose to this most sensitive life stage. Even though embryotoxicity is the endpoint in Nosek et al. (1993), there are additional assumptions and potential inaccuracies incorporated into a NOAEL based on the intraperitoneal dose to the adult as compared to a NOAEL based on the dose to the egg. If the EPA pharmacokinetic model is used, an assumption is made that the pharmacodynamics and metabolic capacities of pheasants are similar to bald eagles. Additionally, it must be assumed that the pharmacodynamics of TCDD deposition into the developing egg is similar when the routes of exposure are intraperitoneal injection or orally via the diet. These are completely untested assumptions that could lead to a large inaccuracy in the proposed model. The proposed pharmacokinetic model also makes the additional assumption that a steady-state accumulation has been attained. The Nosek et al. (1992a) study was clearly a subchronic exposure (10 weeks) in which steady-state was not achieved. The EPA recognized this fact in their assessment of TCDD risk to wildlife published earlier this year (U.S. Environmental Protection Agency 1993). In the derivation of a risk value for TCDD, an extrapolation factor of 10 was used (U.S. Environmental Protection Agency 1993), yet in the derivation of a TMDL for the Columbia River this subchronic to chronic extrapolation factor is missing.

The NOAEL in chicken embryos for lethality based on egg injection was determined to be 100 pg/g TCDD (Henshel et al. 1993a). The LD50 in this same study was estimated to be 115 pg/g (probit method) or 150 pg/g (interpolation method) and 300 pg/g injected into the yolk caused complete mortality (Henshel et al. 1993a). Therefore, there is a very steep dose-response curve for embryo lethality in chicken embryos. Nearly identical results were obtained by the Food and Drug Administration (FDA) in an unpublished egg injection study with chickens (Verret 1976). In testimony to the U.S. Congress, Verret (1970) suggested that a NOAEL for TCDD in chicken embryos based on lethality and teratogenicity would be 10-20 pg/g. Henshel et al. (1993b) found that teratogenicity occurred as low as their lowest dose of 10 pg/g. However, the statistical analysis has not been completed on the later studies of Henshel et al. (1993b). These studies when considered together suggest the need of a safety factor to extrapolate from the NOAEL for lethality to a NOAEL for teratogenicity and other non-lethal endpoints. Other groups (Poland and Glover 1973) using the same model system, the developing chicken embryo, have noted sublethal effects (2-fold AHH induction at 10 pg/g) that occur in this species prior to embryo lethal effects. This is different than studies with pheasants (Nosek et al. 1993) in which embryo lethality was the most sensitive toxicological endpoint of TCDD exposure. Unfortunately, there is no information on bald eagles as to whether they might respond more like the chicken or pheasant model. With this uncertainty, it is prudent to use a factor of 10 to account for non-lethal effects which could be important in the subsequent survival of bald eagle chicks. Therefore, the Service believes that the NOAEL in bald eagle eggs for the protection of the population from the effects of TCDD is 10 pg TCDD/g of egg. Protection of individuals will require an additional uncertainty factor of 10, reducing the NOAEL to 1 pg/g (See Section on Intra-species Sensitivity Factor).

This NOAEL is supported by the conclusions in other studies. For example, in a field study with wood ducks (*Aix sponsa*), White et al. (1993) found reduced hatching success and duckling survival at 21 pg/g TCDD (LOAEL-Lowest Observed Adverse Effect Level). A NOAEL can be determined from the LOAEL in the White et al. (1993) study by dividing his LOAEL by a factor of 10, producing a NOAEL of 2.1 pg/g for wood ducks.

SSF: EPA used an inter-species sensitivity factor of ten. This assumes that eagles are ten times more sensitive to dioxin than pheasants. In our opinion, it is reasonable to assume that eagles are more sensitive to dioxins than pheasants; the question is how much more sensitive. Chickens are generally accepted to be the most sensitive avian laboratory species to compounds that have a similar mode of action as dioxin (Gilbertson et al. 1991). Earlier studies (Britton and Houston 1973, Dahlgren et al. 1972, Lillie et al. 1974) with chickens and pheasants showed that chickens were about three times more sensitive than pheasants to dioxin-like compounds in adult birds. Later studies showed that chickens were much more sensitive to dioxin-like compounds; 20 (Cheung et al. 1981) and 25 to 50 times (Brunstrom and Darnerud 1983, Brunstrom and Reutergardh 1986) more sensitive than pheasants in developing embryos. If we accept the assumption that eagles are at least as sensitive as chickens, then this literature would indicate a sensitivity factor of 10 would not be sufficient. In addition, Nosek et al. (1993) also found that while the most sensitive indicator in pheasants was embryo mortality, other species showed more sensitive impacts such as cardiovascular malformations, subcutaneous edema, or liver lesions at much lower concentrations as reported by Cheung et al. (1981), Brunstrom and Darnerud (1983), Brunstrom and Anderson (1988), and Henshel et al. (1993b). In the absence of more direct information on the sensitivity of eagles, we must assume that eagles are at least as sensitive as chickens to dioxin-like compounds and could be even more sensitive than chickens. Thus, a NOAEL based on the injection of TCDD into adult ring-necked pheasants may not provide adequate protection for bald eagles.

$Weight_{(eagle)}$: An adult bald eagle weight of 4.5 kg was used in the equation, based on Bortolotti (1984), Palmer (1972), and Stalmaster and Gessaman (1984). However, this weight is generally defined as the average weight of male eagles (Stalmaster 1987). The male bald eagle is smaller than the female eagle, which weighs an average 5.3 kg. It is logical to assume that the female will be the point of transfer of a contaminant to an egg. It would be appropriate to use the weight of the female, not the male. The weight of the female is 17 percent greater than the weight of the male used in the equation. However, as the weight of a bird increases, the food consumption goes down per kilogram of body weight. Consequently, the amount of exposure will remain relatively the same.

Water Consumption: The drinking rate of 0.16 l/day was derived from an equation that relates water consumption to the weight of an animal (Calder and Braun 1983) and is based on a bird weight of 4.5 kg. Water consumption in this equation appears to have little affect on the wildlife value. Using the weight of a larger eagle will only amount to inconsequential changes in the drinking rate and little affect on the calculation of a water quality criterion.

Fish Consumption: EPA's risk assessment assumes a diet of 100 percent fish. This assumption is based on data found in Garrett et al. (1988), that reports a diet of 90 to 94 percent fish. However, this diet was based on foraging observations of both resident and non-resident birds during the winter and breeding seasons. Garrett et al. (1988) actually reports that diet during the breeding season constituted 71 percent fish and 27 percent birds. The bird diet was composed of half fish-eating birds, such as cormorants and gulls and the other half constituted nonfish-eating birds, such as mallards, buffleheads, and coots. These breeding season dietary estimates were determined from an analysis of prey remains in the nest structure. Field observations of prey captures at one site on the Columbia River during the breeding season indicated a higher percentage of fish consumption, 90 percent (Watson and Anthony 1986). These observations would have included both breeding and nonbreeding eagles. Generally, nonbreeding eagles are believed to capture more fish than birds because they are less experienced. Older birds are more experienced, likely to take more birds, and probably are of breeding age. It is possible that the analysis of prey remains in the nest structure may underestimate fish consumption, as described by Kozie and Anderson (1991), but it is the most reliable estimate available for the breeding Columbia River eagles at this time. Other studies have also documented a large percentage of birds in the eagles' diet (Grub 1976, Frenzel 1984, Swenson et al. 1986, Vermeer and Morgan 1989). The Endangered Species Act requires that the best available data be used in a consultation and the data by Garrett et al. (1988) can not be ignored. Fish are generally not as accessible and waterfowl are more plentiful during the winter months, and eagles are more likely to take a larger percentage of birds. For these reasons, it would be more appropriate to assume a diet that includes fish-eating birds, not a diet entirely based on fish.

Fish-eating birds have been documented to accumulate several organochlorine based compounds at higher concentrations than fish. Frenzel (1984) and Kozie and Anderson (1991) documented that fish-eating birds preyed upon by bald eagles were a greater source of organic compounds in eagle diets than fish. Concentrations of dioxins have not been determined for fish-eating or nonfish-eating birds from the Columbia River. However, preliminary data on concentrations of dioxin in eggs of some fish-eating birds indicates that these species are accumulating TCDD in their tissues [Table 2] (U.S. Fish and Wildlife Service unpublished data). Concentrations in eggs are at least 10 times higher than found in fish tissues. In general, organic contaminants will occur at greater concentrations in an adult bird than in their egg. Thus, eagles consuming fish-eating birds are likely being exposed to higher concentrations of TCDD.

Dioxins are organochlorine based compounds known to biomagnify in food chains. Bald eagles occupy the highest trophic level in their food chain and are likely to be exposed to greater TCDD concentrations than other species. The EPA model (Bradbury 1992) does not account for biomagnification of TCDD in the food chain.

Bioaccumulation Factor: EPA's risk assessment uses a Bioaccumulation Factor (BAF) of 90,000 based on a fish with an average lipid content of 9 percent. A BAF specific for the Columbia River has not been determined and the most appropriate BAF is questionable. More recent information on the particulate organic carbon (POC) in the Columbia River gives a BAF closer to 22,000. The data used to calculate this BAF is limited and more recent and detailed information on POC is needed to refine the BAF. Additionally, use of POC data to calculate a BAF is based on a lacustrine system, not on a riverine or estuarine system. These discrepancies and unknowns in the BAF indicate that further work is needed to determine a more accurate BAF. However, a BAF of 22,000 may be reasonable, until more recent, site specific information is collected.

Intra-species Sensitivity Factor: A sensitivity factor of 10 was used to account for sensitivity of individuals within a population. The Endangered Species Act requires protection of individual listed species, thus, the use of a sensitivity factor to protect individuals is appropriate.

Exposure Level: At a TMDL concentration of 0.013 pg/L TCDD, eagles would be exposed to 130 pg/kg body weight/day (Bradbury 1992). Using the Nosek (1991) pheasant NOAEL, EPA determined that bald eagles would not be affected when exposed to a TCDD concentration of 140 pg/kg body weight/day (Bradbury 1992). This was determined by adjusting the Nosek (1991) NOAEL of 14,000 pg/kg/day. EPA assumed that eagles would be more sensitive to dioxin than pheasants and adjusted the NOAEL by a factor of 10 to account for their greater sensitivity. EPA then reduced the NOAEL by another factor of 10 to compensate for sensitive individuals within a species. These adjustments produce a bald eagle NOAEL of 140 pg/kg body weight/day. Based on earlier discussions, the SSF factors of 10 may not be sufficient. A larger sensitivity factor would be needed to account for greater sensitivity of eagles (assuming they are as sensitive as chickens) and greater sensitivity of the embryo.

Alternative Hazard Assessment

The above described risk assessment, as we understand it, is based on several assumptions and does not use site specific data; adequately account for species sensitivity; incorporate a diet that includes fish-eating birds; or account for potential biomagnification of TCDD in the food chain. Because of these concerns and the need to evaluate what could be a safe exposure level for bald eagles, we developed an alternative hazards assessment. This assessment is based on results of a Service work group that reviewed the water quality criterion (Bradbury 1992) and development of the Great Lakes wildlife criterion (U.S. Environmental Protection Agency 1991) to evaluate whether proposed criterion would be protective of bald eagles. Workgroup members included Bob Anthony (Oregon Cooperative Wildlife Research Unit), Mary Gessner (Division of Environmental Contaminants), Charles Henny (Pacific Field Research Station), Tim Kubiak (East Lansing Field Office), Carol Schuler (Portland Field Office), Ken Stromborg (Green Bay Field Office), Don Tillitt (National Fisheries Contaminant Research Center), and Stanley Wiemeyer (Reno Field Office).

Sufficient data are available from field and laboratory studies to begin to construct a hazard assessment for dioxin in the Columbia River. We have developed a simple hazard assessment model which has four basic components to assess a water quality criterion for bald eagles. These include a NOAEL for the most sensitive life stage of similar species; the degree of magnification of a contaminant from forage to target organism and life stage (e.g. egg); the concentration of dioxin in forage fish; and the bioaccumulation factor from water to forage. This simplified hazard assessment is a common approach used by regulatory agencies to obtain a reasonable amount of protection for natural resources. This approach uses fewer assumptions, can be monitored for compliance, uses resource data from the Columbia River, can be improved by collecting more information from the Columbia River, and uses direct effects on the most sensitive part of the life cycle - the egg.

The basic model to calculate a NEL for water is as follows:

$$\text{NOAEL}/\text{BMF}_{(\text{total})} = \text{Target Dietary Concentration}$$

$$\text{Target Dietary Concentration}/\text{BAF} = \text{No Effect Level (NEL)}$$

NOAEL:	TCDD concentration in an egg that produces no observable adverse effects [1.0 pg/g (Henshel et al. 1993a)]
$BMF_{(total)}$:	Total Biomagnification Factor - is the amount of TCDD magnified in the food chain from forage items to an eagle egg [21, 54]
Target Dietary: *Concentration*	Target Dietary Concentration (TDC) - Dietary concentration that would be protective of bald eagles
BAF:	Bioaccumulation Factor - rate of bioaccumulation of TCDD in a dietary item with a 9 percent fat content [22,000]
No Effect Level: *(NEL)*	Concentration in water that would not be hazardous to bald eagles

This assessment model provides a reasonable estimate of dietary concentrations necessary to achieve a NOAEL concentration in eagle eggs. Contaminant concentrations and their potential effects to eagles can then be assessed by monitoring egg and forage concentrations. Concentrations in forage items can be easily monitored, particularly concentrations in forage fish. Establishment of a target forage concentration will allow for monitoring to assure that the NOAEL for eagle eggs is not exceeded. For this assessment, a TCDD NOAEL was used based on the most critical and sensitive lifestage, the developing embryo. Research by Henshel et al. (1993a) produced a NOAEL for the chicken embryo of 100 pg/g, based on lethality. To account for nonlethal effects, the NOAEL is reduced by a magnitude of 10 to 10 pg/g. The NOAEL must also protect for sensitive individuals; thus, the NOAEL must be further reduced by a factor of 10 to 1 pg/g TCDD. Similar NOAELs were determined by Cheung et al. (1981), Verret (1976), and White (1993).

The total biomagnification factor (BMF) incorporates magnification of TCDD from consumption of fish, fish-eating birds, and nonfish-eating birds. Because bald eagles are at the top of the food chain, it is necessary to consider magnification of a contaminant through each forage level of their food chain. Braune and Norstrom (1989) found that organochlorine compounds were biomagnified 21 times from the forage fish to the herring gull egg in the Great Lakes. The actual BMF for the Columbia River is not known, but may be higher considering that the eagle diet also comprises fish-eating birds. The actual dietary exposure that eagles will receive when consuming birds is not known. Additionally, no data is available on TCDD concentrations in nonfish-eating birds versus fish-eating birds. We are making the assumption that nonfish-eating birds will have similar concentrations of TCDD as fish. Studies by Frenzel (1984) indicate that DDE concentrations in mallards (nonfish-eating bird) were similar to concentrations found in fish. In a situation where food preferences of a species are not known, a proportional dietary approach should be used to determine the total BMF. Using the equation described above to calculate a target fish concentration, the total BMF can be calculated by:

$$BMF_{(total)} = F_{(f)}[BMF_{(f)}] + F_{(fb)}[BMF_{(f)}][BMF_{(b)}] + F_{(nfb)}[BMF_{(f)}]$$

$F_{(f)}$ - frequency of fish in the diet

$F_{(fb)}$ - frequency of fish-eating birds in the diet

$F_{(nfb)}$ - frequency of nonfish-eating birds in the diet

$BMF_{(f)}$ - biomagnification factor from forage fish to egg

$BMF_{(b)}$ - biomagnification factor from forage bird to egg

$BMF_{(total)}$ - combined biomagnification factor

The BMF will be dependent on the dietary consumption of birds. A diet based on 100 percent fish will have a BMF of 21, based on Braune and Norstom (1989); diet with 90 percent fish and 10 percent birds (half fish-eating birds) will have a BMF of 54; whereas, a BMF of 102 will be calculated with a diet that includes 25 percent birds (half fish-eating). Currently, a site specific BMF for the Columbia River can not be reliably calculated because of temporal and spatial inconsistencies in available fish and bird data. Using the range of biomagnification factors (described above) and an average NOAEL, a target fish concentration can be calculated. The most accurate BMF will be based on site specific information, but until this information becomes available it would be useful to look at a range of BMFs. The remaining discussion will focus on the a BMF that is based on a diets of 90 and 100 percent fish.

$$NOAEL/BMF_{(total)} = \text{Target Fish Concentration}$$

100% Fish Diet: 1 pg/g / 21 = 0.048 pg/g or 48 pg/kg

90% Fish Diet: 1 pg/g / 54 = 0.019 pg/g or 19 pg/kg

Using the range of BMFs described above will produce a target fish concentration that ranges from 19 pg/kg (BMF=54) to 48 pg/kg (BMF=21). A safe, target fish concentration for the Columbia River, using the median value from this model, is 34 pg/kg.

A bioaccumulation factor (BAF) is used to determine the bioaccumulation of TCDD in the water to forage fish. The Great Lakes initiative to develop a TCDD wildlife criterion (U.S. Environmental Protection Agency 1991) and EPA's (1993) TCDD risk assessment use a BAF of 90,000 for a fish with 9 percent lipids. Information on percent organic carbon in the Columbia River indicate that a lower BAF of 22,000 may be appropriate. However, the actual BAF for the Columbia River is not clearly understood, and additional information, such as a mass balance modeling approach, is needed to determine a more accurate BAF for the Columbia River. For discussion purposes, we calculated a no effect level (NEL) using the 22,000 BAF, since this BAF was based on available information from the Columbia River.

Target Fish Concentration/Bioaccumulation Factor = No Effect Level (NEL)

90% Fish Diet: 19 pg/kg / 22,000 = 0.0009 pg/l

100% Fish Diet: 48 pg/kg / 22,000 = 0.0022 pg/l

The range of BMFs described above would produce a NEL ranging from 0.0009 pg/l (BMF=54) to 0.0022 pg/l (BMF=21). These NELs range from 6 to 14 times lower than the current TMDL established by EPA. Based on this model and using the median between the range of BMFs, we believe that the TMDL (NEL) for the Columbia River should be approximately 10 times lower (0.0013 pg/l) than the current TMDL. In lieu of site specific data from the Columbia River and because of uncertainties associated with TMDL loading allocations and until improved knowledge can be used to refine estimated no effect levels, we believe the lower target concentration of 0.0013 pg/l is needed to protect the bald eagle population along the Columbia River. The current TMDL for TCDD discharges to the river will not provide sufficient protection.

Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have independent utility apart from the action under consideration. Both interdependent and interrelated activities are assessed by applying the "but for" test, which asks whether any action and its associated impacts would occur "but for" the proposed action.

Interrelated and interdependent activities and associated impacts have been addressed in the description. No additional interrelated or interdependent activities were identified or analyzed.

VI. CUMULATIVE EFFECTS

Cumulative effects are those effects of future non-Federal (State, local governments, or private) activities on endangered and threatened species or critical habitat that are reasonably certain to occur within the action area of the Federal activity subject to consultation. Future Federal actions are subject to the consultation requirements established in section 7 and, therefore, are not considered cumulative to the proposed action.

No future non-Federal actions were identified that could be considered cumulative effects to the action specified in this consultation. Any actions resulting in increased discharges of TCDD to the Columbia River that may result in exceedence of the TMDL are subject to some level of Federal involvement.

VII. INCIDENTAL TAKE

Section 9 of the Act, as amended, prohibits take (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Under the terms of section 7(b)(4) and 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with this incidental take statement. Failure to meet the following terms and conditions will constitute loss of the exemption provided for take under section 7(b)(4) and 7(o)(2) of the Act.

Compliance with the terms and conditions of this section have no bearing on terms and conditions which may be necessary for taking under the Endangered Species Act of 1973, as amended, as may be specified by the National Marine Fisheries Service.

The Service expects that establishment of the EPA proposed TMDL for TCDD is likely to result in incidental take of bald eagles due to detrimental effects resulting from chronic toxicity such as reduced reproductive success, and other behavioral and physiological impairments that may act to reduce the eagle's ability to survive. Due to the extreme toxicity of this compound, the potential exists for mortality arising from chronic toxicity and additive activity with other compounds present in the Columbia River System. Because of the inherent biological characteristics, limited information on the mode of action of TCDD singularly and in combination with other compounds, and technical and expense related difficulties with monitoring and analysis, the likelihood of discovering an individual death attributable to TCDD toxicity is very small. For example, induced behavioral modifications potentially leading to death, the length of time from actual mortality to discovery, scavenging and stream transport of carcasses, and decomposition make finding an incidentally taken individual bald eagle unlikely. Furthermore, effects of regulatory actions such as TMDLs for highly toxic compounds are largely unquantifiable in the short term, and may only be measurable as long-term effects on the species' food chain, reproduction, and population levels. Therefore, even though the Service expects incidental take associated with TCDD levels, the best scientific and commercial data available are not sufficient to enable the Service to estimate a specific amount of incidental take to the species itself. In instances such as these, the Service has designated the expected level of take as unquantifiable.

Based on available toxicity information and contaminant assessments of eagles, eagle eggs, and prey species, the Service anticipates the incidental take of an unquantified number of bald eagles along the Columbia River due to chronic toxicity resulting from exposure to TCDD and additive or synergistic toxicity resulting from exposure to TCDD and other compounds (DDE, PCB, dioxin, and furan congeners) present within the Columbia River System.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize the incidental take authorized by this Biological Opinion:

1. Reduce TCDD contamination in the Columbia River to lessen the effects of TCDD on bald eagle productivity and survivability.

Terms and Conditions

To implement this reasonable and prudent measure, the Service offers the following mandatory terms and conditions. Compliance with these terms and conditions is necessary for exemption from the prohibitions of Section 9 of the Act.

1. Continue to implement the current TMDL of 0.013 pg/l through waste load allocations. During the next five years, information will be gathered to better define a safe level or TMDL in the Columbia River. In 1999, EPA will re-initiate formal consultation on this issue to determine whether a TMDL of 0.013 pg/l will adequately protect bald eagles in the Columbia River. The Service's review, using current information, indicates that the TMDL needs to be lowered to 0.0013 pg/l to reduce effects on nesting bald eagles. If at any time new information indicates that the current TMDL further threatens bald eagles, EPA shall immediately re-initiate consultation.

2. Establish a monitoring program, in cooperation with the Service, to determine whether the TMDL is successful in reducing TCDD concentrations in the Columbia River to

nonhazardous levels. For example, monitoring of concentrations in fish tissues may provide the best tool for assessing the status of dioxin in the river. Periodic monitoring of concentrations in fish will show whether TCDD is declining and whether bald eagles will be adequately protected. A monitoring plan shall be developed and reviewed by the Service and other relevant agencies. A monitoring program to assure consistency with the current TMDL goal needs to be implemented in 1994.

3. During the next five years, collect new information and reevaluate the waste allocation model and models used to calculate no effect levels and better define the dioxin load in the Columbia River and potential threats to bald eagles. The following information is needed to reevaluate these models:

    a. Better define and possibly control loadings from other dioxin sources, such as wood treatment facilities, municipal sewage treatment plants, Superfund sites, and agricultural areas.

    b. Reassess the margin of safety with new information gathered on dioxin sources in the Columbia River Basin.

    c. Attempt to define the level of dioxin contribution from background sources.

    d. Better quantify dioxin concentrations and related parameters of importance (e.g. organic carbon) in appropriate components of the system for use in derivation of refined BAFs and BMFs.

    e. Evaluate the significance of other dioxin and furan congeners and other organochlorine compounds on bald eagles and how these compounds affect the setting of a TMDL just for TCDD.

4. Evaluate the accumulation and effects of dioxin on Columbia River bald eagle populations during 1994/95 and reassess these conditions in 1998 prior to re-initiation of the consultation. An indicator species, such as double-crested cormorants or ospreys, should also be monitored during both sampling periods, in case the stability of the Columbia River eagle population does not permit sampling.

The incidental take statement included in this biological opinion for bald eagles satisfies the requirements of the Act. This statement does not constitute authorization for take of listed migratory birds under the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, or any other Federal statutes.

As more information becomes available on the Columbia River, the TMDL and the toxicity of TCDD, the EPA should enter into discussions with the Service to reevaluate the TMDL and determine what would be a safe concentration for bald eagles and other sensitive species.

Disposition Statement/Reporting Requirements

The EPA or a designated representative shall prepare a written report with dates, locations, circumstances surrounding the taking and/or explanation of the causes of the taking. Written reports should be directed to Field Supervisor, Attn: Endangered Species, U.S. Fish and Wildlife Service, 2600 S.E. 98th Avenue, Suite 100, Portland, Oregon 97266 (phone: 503-231-6179).

The Service is to be notified within three working days upon locating a dead, injured, or sick endangered or threatened species specimen. Initial notification must be made to the nearest Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Any bald eagle found dead or injured should be turned into the U.S. Fish and Wildlife Service, Division of Law Enforcement, Wilsonville (503) 682-6131 or U.S. Fish and Wildlife Service, National Forensics Laboratory, Ashland, Oregon.

VIII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. The term "conservation recommendations" is defined as suggestions from the Service regarding discretionary measures (1) to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, (2) conduct studies and develop information, and (3) promote the recovery of listed species. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's 7(a)(1) responsibilities. The Service recommends that the following conservation measures be implemented to further the conservation of bald eagles along the Columbia River:

1. Strive towards elimination of dioxin discharges to the Columbia River Basin to comply with the goal of the Clean Water Act, which is to eliminate discharges of toxic pollutants by 1985.

2. Consider the short- and long-term effects of dioxin discharges on the entire Columbia River ecosystem, not just one species.

3. Evaluate other dioxin-like compounds because they will contribute to dioxin-like toxicity. A TMDL based solely on one dioxin congener will not adequately protect or restore the health of the Columbia River system. All monitoring and reevaluations of the TMDL should consider other dioxin and furan congeners and PCBs, possibly using the TEQs approach. It may be necessary to develop TMDLs for PCBs and other dioxin and furan congeners.

4. Develop sediment criteria to improve monitoring abilities at specific dioxin sources.

5. Develop better sampling and estimation techniques for the determination of the bioavailable TCDD in water.

IX. CONCLUSIONS

This biological opinion has been prepared specifically to address the effects of implementing a TMDL for TCDD by the EPA, to bald eagles within the Columbia River Recovery Zone. The Service commends the EPA's efforts to establish and allocate daily loads that limit discharge of toxic compounds into the Columbia River System. Further, the Service appreciates past and continuing cooperation and coordination displayed by the EPA in assisting with the gathering and analysis of additional data to allow a more thorough evaluation of potential impacts. While establishing discharge limits for toxic compounds should limit adverse affects to fish and wildlife populations occurring within the area, the persistence of TCDD and other organochlorine contaminants in the Columbia River System may delay or preclude improvements in sediment and water quality, even though implementation results in reduced discharge.

This concludes formal consultation on the action described in the Biological Assessment dated April 5, 1992. Reinitiation of formal consultation is required if: (1) the amount or extent of incidental take is exceeded, as previously described, (2) the provisions and requirements under the Incidental Take section are not implemented, (3) new information reveals effects of the action that may affect listed species or critical habitat in a manner that was not considered in this opinion, (4) commitments and time lines described in the Project Description to offset and avoid project related impacts are not met or adhered to, and/or (5) a new species is listed or critical habitat is designated that may be affected by the action. If you have any questions regarding this opinion, please contact me, Carol Schuler, or Gary Miller at (503) 231-6179.

Sincerely,

Russell D. Peterson
State Supervisor

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