August 18, 2000

Mr. Stephen J. Silva
Maine State Program
U.S. Environmental Protection Agency
1 Congress Street, Suite 1100
Boston, Massachusetts 02203-0001

Dear Mr. Silva:

This is the U.S. Fish and Wildlife Service's (USFWS) biological opinion on the U.S. Environmental Protection Agency's proposed reissuance of National Pollutant Discharge Elimination System (NPDES) permits (Clean Water Act, Section 402) for six kraft pulp and paper mills in Maine, and its effects on the federally-threatened bald eagle (*Haliaeetus leucocephalus*) in accordance with Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*). The six kraft mills are:

Applicant	Mill Location	River
Mead Corporation	Rumford	Androscoggin
International Paper	Jay	Androscoggin
SD Warren (SAPPI)	Hinckley	Kennebec
Lincoln Pulp & Paper	Lincoln	Penobscot
Fort James Company	Old Town	Penobscot
Georgia-Pacific Company	Woodland	St. Croix

Your September 9, 1999 request for formal consultation was received on September 13, 1999. We confirmed initiation of formal consultation in a letter to you dated October 13, 1999.

This biological opinion is based on USEPA's June 8, 1999 description of the proposed permits, and on information exchanged among the USEPA staff, permit applicants, the Maine Department of Inland Fisheries and Wildlife (MDIFW), and the USFWS, during informal and formal consultation. A complete administrative record of this consultation is on file in the USFWS' Maine Field Office, located in Old Town, Maine.

CONSULTATION HISTORY

October 6, 1998 - Letter from S. Silva, USEPA, to G. Russell, USFWS, requesting USFWS concurrence that reissuance of NPDES permits for the Maine pulp and paper mills will not impact bald eagles.

May 6, 1999 - Meeting at the Maine Department of Environmental Protection (MEDEP) office in Augusta to discuss eagle nesting locations, NPDES discharge locations, and dioxin regulations and monitoring. Participants included: K. Tripp, USFWS; K. Carr, USFWS; C. Todd, MDIFW; G. Wood, MEDEP; B. Mower, MEDEP; D. Gould, USEPA; S. Silva, USEPA; and D. Cochrane, USEPA.

June 8, 1999 - Letter from S. Silva, USEPA, to K. Tripp, USFWS, describing revised dioxin limits that will be included in the reissued NPDES permits.

July 7, 1999 - Meeting at Penobscot Indian Nation (PIN), Indian Island, to discuss PIN concerns with dioxin and bald eagles. Attendees: J. Banks and D. Kusnierz of PIN, K.Tripp and G. Russell of USFWS.

August 30, 1999 - Letter from K. Carr, USFWS, to S. Silva, USEPA, identifying impacts dioxin may have on bald eagles, and recommending that USEPA initiate formal consultation with the USFWS.

September 9, 1999 - Letter from S. Silva, USEPA, to K. Carr, USFWS, requesting initiation of formal consultation.

October 13, 1999 - Letter from K. Tripp, USFWS, to S. Silva, USEPA, notifying USEPA that all information necessary for consultation has been submitted or is otherwise accessible. The biological opinion will be submitted to USEPA by January 26, 2000.

November 29, 1999 - Meeting among USFWS, USEPA, representatives of the applicants, and the applicant's legal counsel (Pierce Atwood and Associates) to discuss progress on the biological opinion and issues associated with dioxin and bald eagles.

December 1, 1999 - Letter from S. Silva, USEPA, to G. Russell, USFWS, requesting copy of draft biological opinion.

December 8, 1999 - Letter from P. Anderson, Ogden Environmental & Engineering Services, to S. Silva, USEPA, and S. Mierzykowski, USFWS, providing references for alternative risk assessment models.

December 9, 1999 - Letter from W. Taylor, Pierce Atwood, to S. Silva, USEPA, regarding the development of a draft opinion.

January 21, 2000 - Letter from M. Bartlett, USFWS, to S. Silva, USEPA, requesting an extension of the January 26, 2000 deadline for the draft biological opinion until February 10, 2000.

February 9, 2000 - Email from S. Silva, USEPA, to S. Mierzykowski, USFWS, granting an extension of the deadline until February 10, 2000.

February 9, 2000 - Phone conversation between S. Mierzykowski, USFWS, and S. Silva, USEPA, in which EPA granted a second extension of the deadline for the draft biological opinion until February 15, 2000.

February 15, 2000 - Letter from M. Bartlett, USFWS, to S. Silva, USEPA, transmitting a draft biological opinion.

March 14, 2000 - Letter from S. Silva, USEPA, to M. Bartlett, USFWS, providing EPA comments on the draft biological opinion.

April 13, 2000 - Letter from K. Geoffroy, Pierce Atwood, to S. Silva, USEPA, transmitting comments of the Maine kraft mills on the draft biological opinion.

April 13, 2000 - Letter from D. McComb, Eastern Paper, to S. Silva, USEPA, transmitting Lincoln Pulp & Paper comments on the draft biological opinion.

April 14, 2000 - Letter from J. Schwartz, American Forest & Paper Association, to S. Silva, USEPA, transmitting comments on the draft biological opinion.

April 28, 2000 - Letter from N. Bennett, Natural Resources Council of Maine, to M. Bartlett, USFWS, transmitting comments on the draft biological opinion.

May 1, 2000 - Memorandum from J. Giesy, Entrix, Inc., to S. Mierzykowski, USFWS, transmitting dioxin information developed for Rocky Mountain Arsenal, CO.

May 2, 2000 - Letter from S. Silva, EPA, to M. Bartlett, USFWS, providing EPA assurances that any permits issued by the state would require the monitoring plan included in the USFWS' biological opinion.

May 3, 2000 - Letter from J. Banks, PIN, to M. Bartlett, USFWS, transmitting comments on the draft biological opinion.

May 4, 2000 - Meeting between T. Jorling, International Paper Company, and the USFWS Regional Directorate on the draft biological opinion.

June 12, 2000 - Letter from R. Steven and R. Doyle, Passamaquoddy Tribe, to M. Bartlett, USFWS, transmitting comments on the draft biological opinion.

June 26, 2000 - Meeting among T. Jorling, International Paper Company, representatives of EPA Region

1, and the USFWS New England Field Office, on the draft biological opinion.

June 30, 2000 - Letter from T. Jorling, International Paper Company, to L. Murphy, EPA, recounting his impressions of the meeting on the draft biological opinion.

August 7, 2000 - Letter from K. Carr, USFWS, to T. Jorling, International Paper Company, providing information on SPMDs.

BIOLOGICAL OPINION

I. DESCRIPTION OF THE PROPOSED ACTION

The proposed action is the reissuance of NPDES permits for a term of five years, authorizing the discharge of treated process wastewater, non-contact cooling water and storm water runoff from six kraft pulp and paper mills to four Maine rivers (see Appendix A for description of production proposed by each kraft pulp and paper mill). Bleached kraft pulp is made by cooking wood fibers in alkaline sodium hydroxide and sodium sulfide solutions. The pulp is screened, washed, bleached, and then used in making a variety of paper products. The use of elemental chlorine in the bleaching stage has been discontinued. Substitutions for elemental chlorine include: chlorine dioxide, peroxide, and other alternatives. Dioxins and furans have been identified as by-products from elemental chlorine. It has yet to be shown whether discontinued use of elemental chlorine results in elimination of dioxin and furan by-products.

The proposed NPDES permits will reflect the requirements promulgated in the 1998 Federal Cluster Rule (Title 40 CFR 430). The Cluster Rule updates USEPA's old effluent guidelines for the pulp and paper industry by consolidating joint air and water emission and effluent limitations, and requiring analytical testing for chlorinated phenolics and absorbable organic halides. Consultation under Section 7(a)(2) of the Endangered Species Act (ESA) was not undertaken prior to promulgating the rule.

The water effluent limitations apply to bleached paper grade kraft mills, as well as soda and bleached paper grade sulfite facilities. The Cluster Rule establishes limits for toxic pollutants in the wastewater discharged during the bleaching process and in the final effluent from the mills, and reporting requirements as follows:

- 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) concentrations in mill effluent will be less than the Minimum Level (ML) of detection using USEPA Method 1613. Currently, the ML is 10 parts-per-quadrillion (ppq, picogram/liter).

- 2,3,7,8-tetrachlorodibenzofuran (TCDF) concentrations in effluent will also be below the minimum detection level (10 ppq).

- Monthly measurements of dioxin and furan will be taken from bleach plant effluent.

As indicated in a June 8, 1999 letter from USEPA to the USFWS, NPDES permits would also reflect aspects of the Maine State Law LD 1633 [38 MRSA ¶420, subsection 2 I(3)], requiring that mills demonstrate no difference between dioxin levels in fish collected above and below the mills by the year 2002. Your June 8, 1999 letter also documents USEPA's commitment to analyze addled eggs and dead young of eagles recovered in the vicinity of the six kraft pulp and paper mills for a minimum of five years.[1] Analyses will include organochlorine contaminants [polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/Fs), polychlorinated biphenyl (PCB) congeners, pesticides] and mercury (Hg).

I STATUS OF THE SPECIES

A. Species Account

In 1978, the bald eagle was listed as an endangered species in Maine and in 42 of the other contiguous states, and as threatened in the remaining five states (USFWS 1979). At that time, environmental contaminants were shown to be affecting many of the eagle's populations (Wiemeyer *et al.* 1972). Other factors contributing to the eagle's decline included human disturbance at nest sites, habitat loss, and shooting (Palmer 1988). In recognition of the recently improved status of bald eagles, in August 1995, the species was classified throughout the 48 coterminous states as threatened.
On July 6, 1999, the USFWS proposed to remove the bald eagle from the threatened species list (USFWS 1999). The eagle's recovery was attributed in large part to successful habitat protection and management, and the reduction of persistent organochlorine pesticides (e.g., DDT) in the environment. If the bald eagle is removed from the federal list of endangered and threatened species, the USFWS will continue monitoring the species for a minimum of five years. Although eagles may no longer be classified as threatened under the ESA, the species will continue to receive federal protection under provisions of the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d, 54 Stat. 250) and the Migratory Bird Treaty Act (16 U.S.C. 703-712; Ch. 128; 40 Stat. 755). The bald eagle is likewise protected as an "existing and designated use" under the Clean Water Act (33 U.S. C. 1251 *et seq*).

[1] EPA has indicated that their laboratories do not have experience in preparing avian samples for PCDD/F analysis. The Patuxent Analytical Control Facility (PACF) of the USFWS has the experience and analytical capability to prepare and analyze avian samples collected as part of the monitoring program. PACF can also provide EPA or contract laboratories of EPA or the applicant with sample preparation protocols.

The bald eagle is currently listed as a threatened species under Maine's endangered species law (12 MRSA, section 7753). Maine legislation (12 MRSA, Chapter 713, and Ch. 8.05) allows eagle nests to be designated as essential habitat. The Maine legislation provides for protection of eagles from human disturbance and destruction of habitat, but does not address impacts of point or nonpoint source pollution.

B. Current Population Status

The USFWS has geographically delimited bald eagle populations in the coterminous 48 states into recovery populations termed Recovery Regions. Maine is part of the 24-state, Northern States Recovery Region (NSRR) for bald eagles. In developing biological opinions pursuant to Section 7 of the ESA, USFWS policy provides for the evaluation of jeopardy to a vertebrate species such as the bald eagle within its specific recovery region rather than across the species' entire range within the coterminous 48 states.

In 1998, there were more than 2,204 occupied breeding areas distributed across the NSRR - with an estimated average productivity rate of greater than 1.19 young per occupied nest. The Maine eagle population is the stronghold for the species in the northeastern United States, representing 94% of the eagles currently nesting in New England, and 78% of those nesting in New England and New York. The continued health and expansion of the Maine population is crucial to the full recovery of the species in the Northeast. Table 1 depicts 1999 nesting data for Maine, other New England states, and New York.

Table 1. Bald eagle productivity in New England and New York

State	No. of Territorial Pairs	No. of Young Fledged	Productivity
ME	216	207	0.96
MA	11	15	1.36
CT	2	0	0
VT	0	0	-
RI	0	0	-
NH	3	2	0.66
NY	45	64	1.42

The bald eagle's mean productivity rate in Maine between 1990 and 1998 was 0.85 young/occupied nest, which is 26% lower than the average for the entire NSRR. Although the statewide bald eagle population has experienced a gradual but steady increase in the number of occupied nest sites in recent years, reproductive rates within the state are variable. For example, eagles nesting along the Penobscot River have not shown a marked increase in recruitment since 1993. The local population on the Penobscot appears to have reached a plateau, and has experienced periodic setbacks. Among the 16 eagle nesting territories along the main stem of the Penobscot, recruitment appears inadequate to offset mortality and sustain pair residency.

An assessment of approximately 30 years of monitoring shows that Maine's bald eagles have yet to reach the target production level of 1.00 young/occupied nest, a rate regularly surpassed by healthy eagle populations (Sprunt *et al*. 1973). In 1999, bald eagles in Maine occupied 216 occupied nest sites and produced 207 eaglets for a mean production rate of 0.96 fledgling/occupied nest. The ten-year (1990 - 1999) mean production rate for the statewide population is 0.86 fledgling/occupied nest. Eagle success rates over this period are higher in estuarine/marine areas than inland areas; the success in estuarine and marine nesting areas along with the total number of nests in these habitats is responsible for the majority of the overall state productivity for the period of record.

C. Ecology of Maine Bald Eagles

Eagles generally form breeding pairs and establish nesting territories when they sexually mature at about five years of age. Bald eagles demonstrate extreme loyalty to a nesting location, and will continue to use the same territory throughout their lives. An individual territory may contain several alternate nests that are constructed over the years of residency. During the winter months in Maine, eagles that nest in the interior sections of the state may travel to areas of open water to access prey, while coastal-nesting birds remain on their territories throughout the year. Typically, nesting females will lay from one to three eggs. Nesting is generally initiated between mid-March and the end of April, and is followed by a 35-day incubation period. Eaglets fledge from the nest at approximately 12 weeks of age, although they may remain in the nesting territory for an indefinite period of time.

Bald eagles represent top level predators in the environment, foraging extensively on fish and birds. In one food habit study conducted between 1976-80 (Todd *et al*. 1982), fish (primarily brown bullheads and white suckers) comprised nearly 80% of the diet of eagles using interior sections of Maine, while birds (mainly gulls and waterfowl) accounted for 75% of the prey in coastal areas. In a later Maine study, Welch (1994) reported a composition of 60% fish and 20% birds in prey remains collected below eagle nests at riverine sites. The amount of birds in an eagle diet may be even greater prior to egg laying. In Maine, eagle breeding begins in early spring, often prior to ice-out. At that time, foraging opportunities in rivers may be limited due to ice cover, and the only open water may be restricted to areas below mill dams and in shallow riffles. Waterfowl and other birds congregating near these open water areas are likely an important seasonal prey source for breeding eagles. The eagle's dietary preference for fish and waterbirds increases its risk of exposure to contaminants that accumulate in biota in the aquatic environment. Dietary composition and a lengthy reproductive life of 20-30 years (Stalmaster 1987) may significantly influence bald eagles' exposure to environmental contaminants, particularly those that biomagnify within food chains (e.g., Hg, DDE, PCBs, PCDD/Fs).

The four rivers on which discharges are proposed constitute major foraging areas for bald eagles. Little information is available that would indicate that the birds feed extensively outside these river systems during the nesting season (C. Todd, personal communication).

III ENVIRONMENTAL BASELINE

A. Status of species within the action area

The action area includes all eagle nests located within a 25-mile radius of the six kraft pulp and paper mill discharge sites. The 25-mile radius includes nests occurring on the main stem of the rivers, upstream and downstream tributaries, estuaries, and adjacent or nearby watersheds. Twenty-five miles reflects a reasonable foraging range for resident bald eagles breeding in the vicinity of the mills (C. Todd, personal communication). Seasonal foraging distances may be more limited or extensive depending on habitat conditions (e.g., food availability, ice, disturbance, etc.).

There is a total of 92 nests within 25 miles of the six kraft pulp and paper mills (Table 2; see Appendix B for the name and location of each nest). In the last 10 years (1990 - 1999) the average eagle productivity of these 92 nests was 0.82 fledgling/occupied nest.

Table 2. Ten-Year Average (1990 - 1999) Productivity for Bald Eagles Nesting within a 25-Mile Radius of each Mill

Mills	Rivers	No. of Nests	Productivity
Mead Paper	Androscoggin	1	0
International Paper	Androscoggin	5	0.97
S. D. Warren	Kennebec	11	0.97
Lincoln Pulp and Paper	Penobscot	22	0.77
Fort James	Penobscot	15	0.63
Georgia Pacific	St. Croix	38	0.80

IV EFFECTS OF THE ACTION

A. Factors to be considered

1. Kraft Mill Contaminants

Kraft pulp and paper mill operations discharge a variety of hazardous wastes and environmental pollutants into the environment. Under the Cluster Rule, NPDES discharge limits and/or monitoring requirements are promulgated for flow, Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), temperature, whole effluent toxicity, priority pollutants, color, Adsorbable Organic Halides (AOX), Chemical Oxygen Demand (COD), pH, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), 2,3,7,8-tetrachlorodibenzofuran (TCDF), 12 chlorophenolics, chloroform, and fish tissue dioxin (USEPA 1999). Of these pollutants, polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are likely the greatest contaminant threats to bald eagles foraging and breeding in the vicinity of kraft pulp and paper mills.

We fully recognize that kraft pulp and paper mills are not the only source of PCDD/Fs in Maine's rivers. Other point sources (e.g., incinerators, municipal sewage treatment plants) and non-point sources (e.g., regional and global atmospheric deposition from industrial processes) also deposit organic contaminants including PCDD/Fs into aquatic and terrestrial systems (Commoner *et al.* 1998; Environment Canada 1999). Of the industrial processes, however, only a few such as pulp and paper production and some chemical manufacturing, disperse these types of contaminants directly into surface water (Commoner *et al.* 1998). In Maine, kraft pulp and paper mills are considered significant sources of PCDD/F to the aquatic environment (MEDEP 1998). Thus, the focus of this opinion is on the potential impact of mill-related PCDD/F discharges on bald eagles.

Terminology describing dioxins, furans, and similar compounds such as polychlorinated biphenyls (PCBs) can be confusing. In this biological opinion, acronyms are regularly used. The most potent dioxin congener - 2,3,7,8-tetrachlorodibenzo-*p*-dioxin, is abbreviated here as TCDD. For 2,3,7,8-tetrachlorodibenzofuran, a similar convention is used (i.e., TCDF). References to the combined congeners of polychlorinated dioxins and furans are shortened to PCDD and PCDF, or PCDD/F. Individual congeners of dioxins and furans are often expressed in relation to the most potent TCDD congener. Toxic equivalency factors (TEFs) are applied to individual dioxin and furan congener concentrations to express their toxicity relative to TCDD. TEF-adjusted congener concentrations are then summed to derive a TCDD-equivalent concentration called a TEQ. The toxicity of other organochlorine compounds can also be expressed relative to TCDD. Certain congeners of PCBs have also been assigned TEFs to express their toxicity relative to TCDD (Van den Berg *et al.* 1998). Thus, two TEQ conventions are used in this opinion. $TEQ_{PCDD/F}$ is the TEF-adjusted concentration of a sample's dioxin and furan congeners. TEQ_{Total} is the combined TEF-adjusted concentration of the dioxins, furans, **and** PCB congeners in a sample.

PCDD and PCDFs are highly lipophilic contaminants that persist in the environment, bioaccumulate in fish and wildlife, and biomagnify through food chains (Eisler 1986). In a number of animal studies, the most toxic dioxin congener, TCDD, was lethal or caused sublethal effects, including weight loss, liver dysfunction, weakened immune systems, reproductive damage, and birth defects (ATSDR 1998). In humans, TCDD exposure causes chloracne, and may cause cancer (ATSDR 1998). In laboratory studies using birds, effects of TCDD exposure included enzyme induction, immune suppression, increased nestling mortality, reproductive toxicity, developmental toxicity, and carcinogenicity (Tillitt *et al.* 1991, Nosek *et al.* 1993a).

Biological and biochemical effects of PCDD/F and dioxin-like compounds (e.g., coplanar polychlorinated biphenyls, PCBs) have been reported in field and laboratory studies with bald eagles and other wild birds. Elliott *et al.* (1996a) found significant differences in cytochrome P4501A induction, ethoxyresorufin-*O*-deethylase (EROD) and benzyloxyresorufin *O*-dealkyase (BROD) activities in bald eagle chicks from nests near pulp mills compared to reference sites. In great blue herons (*Ardea herodias*), differences in embryonic growth among three colonies in British Columbia were attributed to PCDD/F contamination from pulp and paper mills (Hart *et al.* 1991). The growth changes in heron chicks included shortened beak, scarcity of down follicles, and subcutaneous edema. In waterfowl, PCDD/Fs have been associated with adverse reproductive effects. White and Seginak (1994) linked reproductive impairment in wood ducks (*Aix sponsa*) to dioxins and furans. In their Arkansas study area near a former chemical plant, they found hatching success and duckling production negatively correlated with egg dioxin toxic equivalents (TEQs). Subcutaneous edema of the head and neck and lower bill deformities were also found in embryos of one failed wood duck clutch. Henshel (1998) found brain asymmetry in chickens exposed to TCDD, and reported similar effects in herons, cormorants, and eagles exposed to a mixture of contaminants including TCDD. It is not known, however, if these brain deformities lead to behavioral or physiological impacts in individual birds (Henshel 1998). TCDD is also an endocrine disruptor (Colborn and Clement 1992) and chronic exposure to TCDD and other organochlorine pollutants (e.g., DDT, PCB) may alter sexual development and functions in fish-eating birds (Fox 1992). It is important to note that these structural and biochemical abnormalities during embryonic development may not result in discernible critical functional deficits until the birds reach sexual maturity (Fox 1992).

2. PCDD/F in Maine Bald Eagles

No PCDD/F eagle tissue data have been collected in Maine since 1993.[2] In fact, there are very few PCDD/F data for Maine eagles. Dioxins and furans have been detected in blood and eggs of bald eagles living adjacent to the Penobscot River, but there are no data available regarding the extent of PCDD/F exposure in eagles using the Androscoggin, Kennebec, or St. Croix Rivers. In 1993, three addled eggs were recovered from two nest sites ten miles upriver of Lincoln Pulp and Paper Company, and chemically analyzed (Table 3). TCDD levels in these eggs ranged from 0.8 pg/g to 23.5 pg/g, while corresponding TEQs $_{PCDD/F}$ ranged from 2.5 pg/g to 84 pg/g. TCDD toxic equivalents in these three eggs were determined using World Health Organization toxic equivalency factors for birds (TEFs; Van den Berg *et al.* 1998).

Table 3. Concentrations of 2,3,7,8-TCDD and TEQ $_{PCDD/F}$ in bald eagle eggs from two nests along the Penobscot River, Maine

Nest & Sample No.	Concentration (pg/g wet weight)	
	2,3,7,8-TCDD	TEQ $_{PCDD/F}$
190B	18.6	84
208A-1	23.5	62

[2] Four eagle eggs collected in 2000 have been submitted for contaminant analysis.

208A-2	00.8	2.5

The 1993 egg data appear elevated as compared to other studies[3] of eagles and osprey (*Pandion haliaetus*) living near kraft mills, especially since the Maine data were from nests ten miles **upriver** of a dioxin discharge. For example, Elliott *et al.* (1996b) found significantly greater mean concentrations of TCDD in bald eagle eggs collected near three British Columbia kraft pulp and paper mills (44 pg/g, 45 pg/g, and 84 pg/g) than at a reference area (15 pg/g). Woodford *et al.* (1998) found significantly greater $TEQ_{PCDD/F}$ concentrations in osprey eggs taken downstream of kraft mills than in a reference area. Eggs taken downstream of Wisconsin mills in 1993 had a mean $TEQ_{PCDD/F}$ concentration of 119 pg/g, while eggs from the reference area had a mean $TEQ_{PCDD/F}$ concentration of 4 pg/g. Augspurger *et al.* (1996) found osprey eggs taken near a North Carolina pulp mill to have a mean $TEQ_{PCDD/F}$ concentration of 33 pg/g, which was significantly greater than the mean of 5 pg/g in eggs from their reference area.

B. Analyses for Effects of the Action

1. Hazard Assessment Model - As noted in the previous section, there is a potential for negative impacts to eagles exposed to PCDD/F in Maine rivers. Although there are few PCDD/F data available for Maine birds, the few available egg data indicate that the compounds do accumulate in bald eagles. Fish tissue data collected by MEDEP (2000) also document persistent, albeit decreasing, accumulation of PCDD/F in Maine river biota. Current PCDD/F levels in fish pose a potential threat not only to wildlife receptors, but also to humans. Levels of PCDD/F and dioxin-like compounds in smallmouth bass (*Micropterus dolomieu*) and white sucker (*Catostomis commersoni*) are so high that the State of Maine has issued consumption advisories to anglers fishing in the Androscoggin, Kennebec, and Penobscot Rivers.

To determine safe TCDD exposure levels for bald eagles, a hazard assessment model was developed by the USFWS for the Columbia River (USFWS 1994). The assessment model was based on the results of a USFWS work group that reviewed water quality criteria (Bradbury 1992), including the Great Lakes wildlife criteria (USEPA 1991) to evaluate whether proposed standards would be protective of bald eagles. Since 1994, the model has been used in other Biological Opinions (Great Lakes, USFWS 1995; Lincoln Pulp & Paper, USFWS 1996) and in an informal consultation (Gladfelter Company, USFWS 1998).

The hazard assessment model has four components to calculate a No-Effect Level in water. These components are 1) a No-Observable-Adverse-Effect Level (NOAEL) for the bald eagle egg, 2) the degree of magnification of a contaminant from forage species to eagle egg, 3) the concentration of TCDD in fish, and 4) the bioaccumulation factor from water to forage species. The hazard assessment model is

[3] Different TEFs have been developed throughout the 1990s (Safe 1990, Ahlborg *et al*. 1994, Van den Berg *et al*. 1998). TEQs are cited as reported by the authors and unadjusted to a particular TEF data set. We recognize the uncertainties and error associated with comparisons of concentrations based on dissimilar TEFs.

represented as:

$$NOAEL_{Egg} / BMF_{Total} = \text{Target Dietary Concentration}$$

$$\text{Target Dietary Concentration} / BAF = \text{No-Effect-Level}_{Water}$$

Where:

$NOAEL_{Egg}$:	TCDD concentration in an egg that produces no observable adverse effects
BMF_{Total} :	Total Biomagnification Factor is the ratio of the concentration of TCDD magnified in an eagle egg to the concentration in the diet
TDC:	Target Dietary Concentration is the concentration of TCDD in its diet that would be protective of bald eagles
BAF:	Bioaccumulation Factor is the ratio of the concentration in forage fish to the concentration in water
NEL_{Water} :	No-Effect-Level $_{Water}$ is the TCDD concentration in water that would not be hazardous to bald eagles

This assessment model provides estimates of TCDD concentrations in water and forage fish that are considered necessary to achieve a NOAEL concentration in eagle eggs. Contaminant concentrations and their potential effects on birds can be assessed by monitoring levels in eggs and diet. The rationale for using certain values in the model is explained below. Comparisons of reported fish and water data to the estimated "safe" forage fish and water values are also provided.

NOAEL $_{Egg}$ - Additional studies have been conducted on the effects of dioxin on bald eagles and other fish-eating birds since the Columbia River, Great Lakes, and Lincoln Pulp and Paper Biological Opinions. In those opinions, a value of 1 pg/g was used for the $NOAEL_{Egg}$ in the hazard assessment model. Recent research, however, suggests that 1 pg/g may be too conservative, and higher $NOAELs_{Egg}$ are suggested. The scientific community presently lacks consensus on a NOAEL for the bald eagle. We have adopted a range of values, because no generally-accepted NOAEL exists and because there are uncertainties and errors associated with NOAELs whether they are developed with laboratory or field exposure data. For example, for a suggested $NOAEL_{Egg}$ of 100 pg TEQ/g derived from field-exposed bald eagles (Elliott *et al.* 1996a), the confidence limits may suggest a $NOAEL_{Egg}$ range between 70 pg/g to 130 pg/g (J. Elliott, personal communication). Therefore, it is appropriate to use a range of $NOAELs_{Egg}$ in the model for this biological opinion. The $NOAELs_{Egg}$ used in the model are 1 pg/g (cited in other biological opinions; extrapolated from a chicken embryo study by Henshel *et al.* 1997), 7 pg/g (Giesy *et al.* 1995; Bowerman *et al.* 1995), 65 pg/g [cited in Buck 1999; extrapolated from an American kestrel (*Falco sparverius*) study with PCB 126 by Hoffman *et al.* 1998)], and 100 pg/g (Elliott *et al.* 1996a). The extrapolation assumptions for the chicken and kestrel studies are outlined in Appendix C.