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Fish as Pollutants: Limitations of and Crosscurrents in Law, Science, Management, and Policy

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FISH AS POLLUTANTS: LIMITATIONS OF AND CROSSCURRENTS IN LAW, SCIENCE, MANAGEMENT, AND POLICY

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Abstract: When we think of pollutants, we either consciously or unconsciously draw a bright line between pollutants and what might be called "natural." That which is natural cannot be a pollutant; that which is a pollutant cannot be natural. It seems odd to speak of live fish as pollutants, as odd as it would be to speak of dioxins as natural. Nevertheless, the traditional definition of fish as natural may be fading as our awareness of the adverse environmental effects of accidental or poorly planned fish introductions increases. Along these lines, a federal court recently found that non-native Atlantic salmon that escape from their pens are "pollutants" within the meaning of the Clean Water Act. Because wild Atlantic salmon is listed as an Endangered Species, Salmon mariculture provides a particularly stark example of when society might aptly consider "fish" to be pollutants. The biological, philosophical, and legal underpinning of our argument, however, transcends aquaculture into the realm of fisheries management, where we advocate that managers focus on improving water quality to the point where the native fish that historically were dominant in the habitat are once again abundant, rather than on managing aquatic ecosystems for stocked species of fish that are relatively unaffected by degraded water quality.

I. INTRODUCTION: FISH AS POLLUTANTS

When we think about pollutants, we either consciously or unconsciously construct a dichotomy of factors that affect environmental quality and draw a bright line between pollutants and what might be called "natural"—what should be in the water, land, or air, what pollutants affect or alter. In this dichotomy of thought, a given factor cannot exist on both sides of the divide. That which is natural cannot be a pollutant; that which is a pollutant cannot be natural. Fish are natural and either affect water quality positively or function as a sort of benign barometer of the effects of pollutants. In contrast, noxious chemicals,

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such as dioxins, are pollutants and can only negatively affect water quality. It may seem odd to speak of live fish as pollutants, as odd as it would be to speak of dioxins as natural. Nevertheless, the traditional definition of fish as natural may be fading in both a philosophical and judicial sense as we become more aware of how accidental or poorly planned introductions of fish can adversely affect the environment.

It has been understood for a long time by fisheries managers that the introduction of exotic fish species can negatively impact aquatic ecosystems. However, it has also recently become apparent that even the introduction of native species may be undesirable. Through ever more sensitive techniques of genetic analysis, it has become possible to differentiate wild from cultured fish of the same species. This in turn has led to a great deal of speculation regarding the impact of cultured fish on wild fish populations, particularly in situations where populations of wild fish are declining. Do cultured fish compete with wild fish for resources? Can cultured fish serve as a vector by which diseases and parasites enter wild populations? Might the introduction of genetic material from hatchery or aquaculture fish to a wild population decrease genetic fitness and consequently survival in the wild population?

In this Article we examine the question of whether fish are and should be treated as pollutants in some contexts. We consider this question primarily in the context of Atlantic salmon mariculture[1] operations—sea-based fish farming operations—that exist off the coast of Maine. Atlantic salmon mariculture presents a particularly appealing milieu in which to examine this question for the following reasons: Atlantic salmon mariculturalists employ strains or stocks of Atlantic salmon that are not native to the Gulf of Maine; there have been documented escapes of farmed Atlantic salmon; recent judicial developments suggest that as a legal matter, such escapees are pollutants; and finally, native, wild populations of Atlantic salmon are endangered. Atlantic salmon that escape from mariculture operations impact wild Atlantic salmon in numerous ways, as do other cultivated fish that are accidentally or intentionally released into waters containing wild populations of the same species. Impacts include the introduction of exotic species or

1. Atlantic salmon mariculture is a form of aquaculture. Aquaculture refers to the farming of aquatic organisms—not only farming of finfish, but also shellfish, crustaceans, and even aquatic plants, in either fresh or saltwater. Mariculture is saltwater aquaculture or a subset of aquaculture. *See* REBECCA J. GOLDBURG ET AL., PEW OCEAN COMM'N, MARINE AQUACULTURE IN THE UNITED STATES: ENVIRONMENTAL IMPACTS AND POLICY OPTIONS 3 (2001), *at* http://www.pewoceans.org/reports/137PEWAquacultureF.pdf.

varieties of fish to new bodies of water, genetic contamination of the wild genome, predation on wild fish, competition with wild fish for food and favorable space, disruptive behavior, stimulation of premature migrations, creation of unacceptably high densities of fish, mixed-stock exploitation problems, predator attraction, and disease and parasite transmission.[2] Potentially, the most serious of these impacts, and the most difficult to document until recent advances in genetic science, is genetic contamination of the wild genome of Atlantic salmon by the genome of cultured Atlantic salmon.[3] Parasite transmission to wild fish is already considered a potentially serious problem in other segments of the aquaculture industry, such as trout farms that provide stocked fish for sport fishing.[4] In the case of the Atlantic salmon, concern has been expressed recently about the possibility of communication of Infectious Salmon Anemia Virus (ISAV) to wild Atlantic salmon from mariculture fish.[5] As the Atlantic salmon mariculture industry grows, escapes of mariculture salmon will increase, and the impacts of mariculture fish on wild Atlantic salmon are likely to be correspondingly severe.

In Part II, we trace the historical abundance and decline of Atlantic salmon in the northeast United States, its life cycle, and the growth of salmon mariculture production in the United States. In Part III, we turn to the legal regime that regulates the discharge of pollutants from mariculture facilities and consider specific rulings that addressed discharges from salmon mariculture and other aquaculture facilities. In More specifically, we focus on the issue of whether an escaped

2. Ray J. White et al., *Better Roles for Fish Stocking in Aquatic Resource Management: Uses and Effects of Cultured Fishes in Aquatic Ecosystems*, 15 AM. FISHERIES SOC'Y SYMP. 527 (1994).

3. For the federal government's interpretation of genetic harm already caused to wild Atlantic salmon by introduced Atlantic salmon, see Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,460 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 224). The potential for genetic contamination of the wild genome also has been well documented in other species of fish, including salmonids. *See, e.g.*, UTAH DIV. OF WILDLIFE RES., CUTTHROAT TROUT MANAGEMENT: A POSITION PAPER, GENETIC CONSIDERATIONS ASSOCIATED WITH CUTTHROAT TROUT MANAGEMENT, NO. 00-26, *available at* http://www.wildlife.utah.gov/fishing/pdf/cutthroat_genetics.pdf (Dec. 29, 2000); W.M. Muir & R.D. Howard, *Fitness Components and Ecological Risk of Transgenic Release: A Model Using Japanese Medaka (Oryzias latipes)*, 158 AM. NATURALIST 1 (2001).

4. *See generally* NAT'L CTR. FOR ENVTL. ASSESSMENT, U.S. ENVTL. PROT. AGENCY (EPA), SHRIMP VIRUS REPORT (1998).

5. Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine, 65 Fed. Reg. at 69,464; W.G. Doubleday, *Is Atlantic Salmon Aquaculture a Threat to Wild Stocks in Atlantic Canada?*, 2 CAN. J. POL'Y RES. 114–20 (2001).

aquaculture specimen is a "pollutant" within the meaning of the law. We then examine the other side of the legal equation in Part IV—the legal status of wild Atlantic salmon populations. In Part V, we consider one threat—disease transmission—that introduced fish populations pose to wild fish populations. Finally, in Part VI, we consider the policy implications of treating non-native and introduced fish as pollutants for the regulation of mariculture and perhaps, more significantly, for the stocking of fish.

II. BIOLOGY, ABUNDANCE AND DECLINE OF ATLANTIC SALMON AND THE RISE OF SALMON MARICULTURE

A. *Historical Distribution, Abundance, and Decline of Atlantic Salmon*

Atlantic salmon, not to be confused with the five Pacific salmon species—Chinook, Coho, Sockeye, Chum, and Pink—is a distinct species[6] native to the North Atlantic Ocean. On the North American coast, their historic range extended from Connecticut to Labrador, while in the eastern Atlantic Ocean, they existed from northern Africa to northeast Russia.[7] Atlantic salmon also are found in Icelandic waters and in waters of Southern Greenland.[8]

Atlantic salmon have historically been very abundant in the northeastern United States. No more than 200 years ago, as many as 500,000 Atlantic salmon returned each year to spawn in New England rivers.[9] Atlantic salmon also ran up into those New York rivers that

6. Although Atlantic salmon, like its Pacific "cousins," is a member of the subfamily salmonidae, Atlantic salmon is a member of the genus *Salmo* (along with brown trout), while Pacific salmon (along with steelhead [rainbow] trout and cutthroat trout) is the genus *Oncorhynchus*. *Fisheries Management, Pacific Region*, *available at* http://www.pac.dfo-mpo.gc.ca/ops/fm/Salmon/biology.htm (Sept. 18, 2002).

7. COMM. ON ATL. SALMON IN ME., NAT'L RESEARCH COUNCIL, GENETIC STATUS OF ATLANTIC SALMON IN MAINE: INTERIM REPORT FROM THE COMMITTEE ON ATLANTIC SALMON IN MAINE 4, *available at* http://www.nap.edu/books/0309083117/html/R1.html (2000) [hereinafter GENETIC STATUS OF ATLANTIC SALMON].

8. *Id.*

9. Historical returns ranged from 300,000 to 500,000 fish. *See* U.S. FISH & WILDLIFE SERV., BIOLOGICAL REPORT ON ATLANTIC SALMON ABUNDANCE, § 4.1.2, *available at* http://library.fws.gov/salmon/asalmon4.html (Oct. 8, 1999) [hereinafter BIOLOGICAL REPORT]. The report cites L. Stolte for the 300,000 figure and K. Beland for the 500,000 figure. L. STOLTE, DEP'T OF THE INTERIOR, THE FORGOTTEN SALMON OF THE MERRIMACK (1981); K. BELAND, ATL. SEA RUN SALMON COMM'N, STRATEGIC PLAN FOR MANAGEMENT OF ATLANTIC SALMON IN THE STATE OF MAINE (1984).

drain into eastern Lake Ontario via the St. Lawrence River and Seaway and possibly strayed as far south along the coast as the Hudson River.[10] Much of this early evidence of the Atlantic salmon's historical numbers was derived from the private journals of settlers and expeditions and constitutes a body of material that now reads like a poetic epitaph to the salmon's former abundance. Here is one example of those early testimonials from a report compiled for the United States Fisheries Commission in 1802:

> It was nothing uncommon for teams fording the rivers and creeks at night to kill salmon with their hoofs. An older settler living in the town of Hannibal told Mr. Ingersoll that one night while driving across Three-Mile Creek the salmon ran against his horses' feet in such large numbers that the horses took fright and plunged through the water, killing one large salmon outright and injuring two others so that they were captured. The farmers living near the smaller creeks easily supplied their families with salmon caught by means of pitchforks.[11]

By the beginning of the last century, Atlantic salmon were already in a state of serious decline in the United States, most importantly because of the construction of mainstream dams on a number of important salmon rivers that blocked passage upstream, and also because of pollution and other environmental factors.[12] By the beginning of the Twentieth century, Atlantic salmon runs had been completely extirpated on such historically important U.S. Atlantic salmon rivers as the Connecticut and the Merrimack.[13] Nevertheless, significant runs of salmon, at least in the sense of representing a genetic reservoir of the southernmost Atlantic salmon populations in North America if not in terms of absolute numbers, continued on a number of other salmon rivers, particularly in the northern part of the Atlantic salmon's U.S.

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10. *See* Dwight A. Webster, *Early History of Atlantic Salmon in New York*, 29 N.Y. FISH & GAME J. 22, 22–24 (1982), *available at* http://www.dreamscape.com/flyman/History-Atlantic-Salmon.htm (describing the occurrence of Atlantic salmon in New York waters via the St. Lawrence Seaway, in Lake Champlain and others; for particular information on occurrence in the Hudson River, see the section entitled "Salmon in the Hudson River").

11. Hugh M. Smith, *Report on the Fisheries of Lake Ontario*, 10 U.S. FISHERIES COMM'N 195, 195–202 (1890) (quoted in Webster, *supra* note 10, at 27).

12. National Maritime Fisheries Service (NOAA), *Protected Resources, Atlantic Salmon*, (May 2, 2003) *available at* http://www.nmfs.noaa.gov/prot_res/species/fish/Atlantic_salmon.html [hereinafter *NOAA Protected Resources*].

13. John M. Anderson et al., Atlantic Salmon on the Brink, 17:1 Endangered Species Update, 15–21 (2000), *available at* http://www.asf.ca/Communications/special/anderson/pdf.

range.[14] Those runs included Atlantic salmon that breed in the Pleasant, Dennys, Machias, East Machias, Narraguagus, Sheepscot, and Ducktrap rivers in Maine, now known as the Gulf of Maine Distinct Population Segment (Gulf of Maine D.P.S.).[15]

Over the past three decades, there has been an accelerated decline in Atlantic salmon numbers.[16] In addition to overfishing and environmental degradation, Atlantic salmon mariculture has been cited as contributing to that decline.[17] Taking Canadian and United States Atlantic salmon together, there has been a ten-fold drop in the number of two-sea-winter Atlantic salmon[18] returning to spawn from the mid-1970s to the present.[19] These fish represent almost all of the spawning potential of all wild North American Atlantic salmon.[20] The vast majority of these fish are of Canadian origin, with only several hundred fish of United States origin.[21]

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14. For information on historic distribution and abundance of Atlantic salmon in North America, see U.S. FISH & WILDLIFE SERV. & NAT'L MARINE FISHERIES SERV., STATUS REVIEW FOR ANADROMOUS ATLANTIC SALMON IN THE UNITED STATES § 4.1.1–.2 (1999), *available at* http://library.fws.gov/salmon/index.html. For information on the genetic importance of the remaining Maine Atlantic salmon, see Endangered and Threatened Species, Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine. 65 Fed. Reg. 69,459, 69,460 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 224).

15. *See infra* notes 252–67 and accompanying text.

16. This decline has been widely documented and commented upon by private groups concerned with the status of salmon and by various government agencies charged with protecting salmon. For an example of documentation by the private sector, see ATL. SALMON FED'N, THE WILD ATLANTIC SALMON: STATE OF THE POPULATIONS IN NORTH AMERICA 2000, *available at* http://www.asf.ca/stateofsalmon/SOP2000E.pdf (2000). For government figures, see U.S. ATL. SALMON ASSESSMENT COMM., 2000 ANNUAL REPORT NO. 12, 1999 ACTIVITIES tbl. 3.2.b (1999), *available at* http://www.fws.gov/r5crc/documents/2000/ascrpt00.pdf (prepared for U.S. Section to North Atlantic Salmon Conservation Organization Annual Report) (Table 3.2.b is titled *Documented: Atlantic Salmon Returns to New England Rivers Over Time*).

17. For a discussion of the risks posed to wild Atlantic salmon by Atlantic salmon mariculture, see BIOLOGICAL REPORT, *supra* note 9.

18. Two-sea-winter Atlantic salmon are fish that spend two winters at sea between the time they leave the freshwater habitats in which they were spawned for the sea and the time they return to those same freshwater habitats to spawn. *See* JOHN KOCIK & RUSSELL BROWN, NAT'L MARINE FISHERIES SERV., ATLANTIC SALMON, *available at* http://www.nefsc.noaa.gov/sos/spsyn/af/salmon/ (Mar. 2001).

19. From 1975 to 1999, the pre-fishery population of two-sea-winter Atlantic salmon of North American origin dropped from 800,000 to 80,000 fish. 1971–1999 INT'L COUNCIL FOR THE EXPLORATION OF THE SEA (ICES) PRE-FISHERY ABUNDANCE ESTIMATES, reproduced in ATL. SALMON FED'N, *supra* note 16, at 1–2.

20. BILL TAYLOR, SUBMISSION TO CANADA'S HOUSE OF COMMONS STANDING COMMITTEE ON FISHERIES ON THE IMPLICATIONS OF THE *MARSHALL* DECISION FOR CONSERVATION OF WILD ATLANTIC SALMON, *available at* http://www.asf.ca/Actions/dropinsalm/marshall/commons99.html. Taylor is the President of the Atlantic Salmon Federation.

21. For the total number of salmon returning to North American rivers over the past three decades

Today, Atlantic salmon are found in the United States in major river systems from the Connecticut River northward into Maine.[22] Not all of these populations are wild. A number of populations have been restored to rivers where Atlantic salmon historically existed but were later wiped out.[23] These populations are generally not self-sustaining, but have been maintained artificially through stocking. The most outstanding example of this is the Atlantic salmon population of the Connecticut River. A restoration program was begun on the Connecticut River in the late 1960s. Restoration efforts included the creation of fish ladders on all mainstream dams and an extensive stocking program. From 1967 to 1999 a total of 68,381,900 Atlantic salmon were stocked in the Connecticut River, primarily as fry.[24] The total number of adult salmon returning to the river to spawn over the same time period was 4835 fish, or an average of 147 fish per year.[25] It is highly likely that these returns would disappear completely without the support of the stocking

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see Anderson, *supra* note 13, at fig. 1. For the total number of salmon returning to U.S. rivers see U.S. ATL. SALMON ASSESSMENT COMM., *supra* note 16, at tbl. 2.3.1. For the total number of salmon returning to rivers of the Maine distinct population segment see Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,461 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 224).

22. For information on historic distribution and abundance of Atlantic salmon in North America see U.S. FISH & WILDLIFE SERV. & NAT'L MARINE FISHERIES SERV., *supra* note 14, at §§ 4.1.1–.2, 4.2.1, fig. 4.1.1. Figure 4.1.1 shows the historic range of salmon in the United States. Although wild population of salmon were extirpated on the southernmost rivers, i.e., the Connecticut and Merrimack, by the end of the twentieth century, minimal runs of those rivers were once again supported by stocking. For a sportsman's view of the limited success of the Connecticut and Merrimack stocking programs, see Roger Aziz, *Atlantic Salmon, the $1 Million Fish*, EAGLE TRIB. (Haverhill), Dec. 15, 2002, *available at* http://www.eagetribune.com/news/stories/20021215/SP_014.htm. For the total number of fish returning to U.S. rivers see U.S. ATL. SALMON ASSESSMENT COMM., *supra* note 16, at tbl. 2.3.1.

23. *See* ATL. SALMON FED'N, *supra* note 16, tbls. 3.2.a–.b. In the second half of the twentieth century, Atlantic salmon returns to the Connecticut, Merrimack, and other rivers were non-existent before the advent of the stocking program. For information on the historic occurrence of the Atlantic salmon in those rivers, see *NOAA Protected Resources*, *supra* note 12.

24. *See* ATL. SALMON FED'N, *supra* note 16, tbl. 3.2.a. Salmon fry are recently hatched fish that have fully resorbed the yolk sac from their eggs, i.e., the smallest and youngest independently-swimming salmon. Alevins are recently hatched salmon that have not resorbed the yolk sac; they typically do not leave the security of the gravel redds, or nesting sites. Fry are typically stocked despite higher mortality rates than would be the case with older fish (for example parr or smolts) because it is only when salmon are very young that they imprint with the smell of their native stream. Thus, it is thought that salmon stocked as fry will return to the streams in which they are released with a greater frequency than would fish stocked at a later life stage. For a good basic overview of the Atlantic salmon lifecycle, see ATL. SALMON FED'N, THE ATLANTIC SALMON, *available at* http://www.asf.ca/Overall/atlsalm.html (2002).

25. ATL. SALMON FED'N, *supra* note 16, tbl. 3.2.b.

program, which means that the Atlantic salmon has not returned to the Connecticut River in any meaningful sense.

Wild populations of Atlantic salmon from the Gulf of Maine D.P.S. northward are supplemented through stocking efforts; however, these populations are generally considered to be self-sustaining. The majority of the wild U.S. Atlantic salmon population is found in the Penobscot River[26] in Maine. Over the period from 1967 to 1999, the Penobscot River accounted for 53,705 salmon, or seventy-one percent of U.S. Atlantic salmon returns.[27] The next most important river was the Connecticut, which accounted for 4835 fish or 6.4 percent of returns over the same time period.[28] The seven rivers that form the Gulf of Maine D.P.S. together accounted for 8027 salmon, or 10.63 percent of returns.[29]

The total return of Atlantic salmon to U.S. waters, including both wild and hatchery-origin fish, has dropped from roughly 5000 fish a year in the mid-1980s to little more than 1000 fish a year at present.[30] As noted earlier, the majority of these fish return to the Penobscot River in Maine, which is not part of the Gulf of Maine D.P.S., with a few hundred fish each year returning to the Connecticut and Merrimack rivers in southern New England and an even smaller number to the seven rivers of the Gulf of Maine D.P.S.[31]

There are a number of indications that the abundance of salmon in the Gulf of Maine D.P.S. is very low. In recent years, the number of salmon from the Gulf of Maine D.P.S. returning to spawn has declined dramatically.[32] From 1995 to 1999, 16 salmon returned to the Dennys River, 0 to the East Machias, 0 to the Machias, 1 to the Pleasant, 211 to

26. The Penobscot River is adjacent to the seven rivers that form the Gulf of Maine D.P.S., but is not considered part of the Gulf of Maine D.P.S. for management purposes.

27. "Returns" are adult salmon that return to spawn; these fish are counted as they pass over fish ladders or dig redds (gravel nests) to spawn. For Penobscot River numbers, see ATL. SALMON FED'N, *supra* note 16, tbl. 3.2.b. The Penobscot River has been stocked heavily with Atlantic salmon over the past several decades. *See id.* at tbl. 3.2.a.

28. *Id.* at tbl. 3.2.b.

29. *Id.*

30. *Id.*

31. *Id.*

32. The number of salmon returning to spawn can never be counted exactly in any river. In addition, there may be wide variation in the reliability of the estimates from river to river. This is because the availability of counting facilities and counters varies from river to river, as well as the visibility and accessibility of spawning redds. Therefore, the returns data must be understood as estimates and not exact counts, and are most useful in terms of trend analysis, i.e., the identification of broad trends over time such as the current long-term decline in abundance.

the Narraguagus, 0 to the Ducktrap, and 32 to the Sheepscot.[33] Also, the pre-fishery abundance index, one-sea-winter fish is very low in spite of improving ocean habitat conditions.[34] The United States Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) (collectively the "Services") attribute the low level to depressed spawning populations of Atlantic salmon in the seven rivers comprising the Gulf of Maine D.P.S. and a consequently low index of juvenile salmon entering the sea.[35] The production numbers of fry and parr (consecutive juvenile freshwater life stages of the Atlantic salmon) and subsequent smolt (young Atlantic salmon leaving freshwater habitats for the sea) are also very low.[36] In part, this is due to unexpectedly high mortality of parr before reaching the smolt stage.[37] About half of the smolt migrating do not reach the Gulf of Maine.[38]

A study conducted on the Pleasant River found that out of a total of 707 smolt, 31 had come from a commercial hatchery upstream and 676 were wild.[39] The fact that juvenile salmon are reared for mariculture along rivers of the Gulf of Maine D.P.S. is a cause for concern. First, escaped smolts join and potentially contribute deleterious genetic material to the wild salmon pool.[40] And second, because salmon are thought to imprint with the odor of their home rivers as fry and parr, it increases the likelihood that mariculture escapees, imprinted with the odor of Pleasant River or other water from the Gulf of Maine D.P.S., might return to the Pleasant River to spawn.[41]

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33. ATL. SALMON FED'N, *supra* note 16, tbl. 3.2.b.

34. Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,461 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 224) (citing WORKING GROUP ON N. ATL. SALMON, INT'L COUNCIL FOR THE EXPLORATION OF THE SEA, 1999 REPORT). Pre-fishery abundance of one-sea-winter Atlantic salmon remained low in 2000. *See* WORKING GROUP ON N. ATL. SALMON INT'L COUNCIL FOR THE EXPLORATION OF THE SEA, 2002 REPORT ON FISHERIES AND STOCKS IN THE NORTH AMERICAN COMMISSION AREA, § 4.2.3, 60, 162 & Fig. 4.2.3.1, 204, *available at* http://www.ices.dk/reports/ACFM/2002/WGNAS/directory.asp.

35. Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine, 65 Fed. Reg. at 69,461.

36. *Id.*

37. *Id.*

38. *Id.* Most of this information comes from studies of the Narraguagus River, but because of similarities between the rivers in the Gulf of Maine D.P.S., the information is probably applicable to the entire Gulf of Maine D.P.S. *See id.*

39. *Id.*

40. In general, escaped salmon potentially contribute deleterious genetic material to the wild salmon pool. *See* GENETIC STATUS OF ATLANTIC SALMON, *supra* note 7, at 20.

41. *See* YURI P. ALTUKHOV ET AL., SALMONID FISHES, POPULATION BIOLOGY, GENETICS, AND

A large variety of human activities have negatively impacted the abundance and distribution of Atlantic salmon, such as creating impediments to migration, water abstraction from salmon waterways, toxic pollution, acidification, deforestation, and the introduction of exotic species.[42] Historically, the operation of commercial fisheries operations also impacted Atlantic salmon stocks. In recent years, commercial fishing pressure on the Atlantic salmon has been reduced, although this would seem to be more a function of reduced salmon stocks and subsequent regulatory actions to reduce fishing pressure on salmon than a function of the increasing Atlantic salmon mariculture industry.[43]

B. Life Cycle of the Atlantic Salmon

Atlantic salmon are anadromous fish—that is, they are born and live as juveniles in freshwater rivers, then migrate to the sea where they mature before returning to their natal rivers to spawn. This basic life cycle may be further subdivided into the egg, alevin, parr, smolt, grilse, salmon, and kelt stages. These life stages define salmon ecology. Salmon are differentially affected by human and other impacts according to a life stage. Therefore, before assessing the effect of Atlantic salmon mariculture on wild Atlantic salmon, it is important to gain an understanding of the life stages of salmon.

Atlantic salmon spawn in late winter and early fall at the headwaters of rivers that empty into the northern Atlantic Ocean, in North America from Connecticut (formerly) northward into Canada, and in Europe at similar latitudes. The eggs are laid in redds, which are nests protected by

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MANAGEMENT 41–45 (2000) (describing homing ability in general in salmon and in particular imprinting).

42. *See* BIOLOGICAL REPORT, *supra* note 9, § 7.3.1 (including Brown Trout in a list of predators on young Atlantic salmon (all Brown trout in North America are introduced)); *id.* § 7.3.3 (where interspecies competition between Atlantic salmon and Brown trout is documented). The Atlantic Salmon Federation as well as the Canadian Department of Fisheries and Oceans have expressed concern over the possibility of competition between Atlantic salmon and rainbow trout. *See* ATL. SALMON FED'N, *Alien Invasion Alert—It Continues in 2001*, *available at* http://www.asf.ca/Research/research.html (last visited Dec. 12, 2002); NOVA SCOTIA SALMON ASS'N, N. ATL. SALMON CONSERVATION ORG., POLICY ON THE INTRODUCTION AND TRANSFER OF SALMONIDS, *available at* http://www.novascotiasalmon.ns.ca/newsandissues/nascopolicy.htm (last visited Dec. 12, 2002).

43. J.B. Dempson et al., *Estimation of Marine Exploitation Rates on Atlantic Salmon* (Salmo salar) *Stocks in Newfoundland, Canada*, 58 ICES J. MARINE SCI. 331, 331–32 (2001), *available at* http://www.stat.sfu.ca/~cschwarz/papers/2001/ICES/paper.pdf.

several inches of gravel.[44] From 2,000 to 15,000 eggs are deposited in a single redd.[45] Although the number of eggs laid by salmon might seem high to the non-specialist, salmon are not particularly fecund by fish standards.[46] The protection afforded by the gravel allows a high percentage of salmon eggs to hatch,[47] as compared to the eggs of other fish that may circulate in the water column or otherwise be exposed to predation. Hatching takes place in late March and early April.[48]

Newly hatched salmon are called alevins, and are dependent upon the egg yolk sac for nutrition.[49] Alevins remain underneath the gravel until the egg sac is absorbed, at which point they emerge to feed and are known as fry.[50] After some time in freshwater, the fry develop a coloration pattern of a series of broad vertical dark bands called parr markings; hence, at this stage of their life, Atlantic salmon are known as parr.[51] Parr remain in freshwater for two to four years,[52] at which point they metamorphose into smolts, the silvery-colored life stage of the salmon that goes to sea.[53] Smolts resemble adult salmon, and once they reach the sea, they are known as salmon.

The Services cited the extremely low abundance of smolts in the Gulf of Maine D.P.S. as an important factor in their decision to list the Maine D.P.S. as an endangered species.[54] The Services attribute this low abundance primarily to a small population of spawning adults.[55] A study on the Narraguagus River showed that about half of the migrating smolt

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44. DEREK MILLS, ECOLOGY AND MANAGEMENT OF ATLANTIC SALMON 9–11 (1989).

45. *Id.*

46. Compare with the fecundity of American eels, which are found with the Atlantic salmon in freshwater and may produce from 2,000,000 to 10,000,000 eggs per mature female in one spawning event. *See* G.P. Barbin & J.D. McCleave, *Fecundity of the American Eel Anguilla Rostrata at 45°N in Maine, U.S.A.*, 51 J. OF FISH BIOLOGY 840, 844 (1997).

47. MILLS, *supra* note 44, at 9–11.

48. *Id.* at 11.

49. *Id.*

50. *Id.*

51. There is some disagreement about the timing of the division between the fry and parr life stages of the salmon, with some authorities saying that fry are known as parr after their first year of life in freshwater, and yet others holding that fry that have dispersed from the redd are known as parr. *Id.* For most fisheries workers, the existence of parr markings is enough to differentiate parr from fry and smolt.

52. *Id.*

53. *See, e.g.*, MASS. DIV. OF WILDLIFE, *Life Cycle of the Atlantic Salmon*, available at http://www.state.ma.us/dfwele/dfw/dfwsal.htm.

54. Endangered and Threatened Species; Final Endangered Statute for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,461–68 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 224).

55. *Id.* at 69,461.

population does not reach the Gulf of Maine.[56] Parr and smolt that escape from commercial hatcheries that supply the Atlantic salmon mariculture industry also may pose a competitive and genetic threat to wild parr and smolt. As noted earlier, a study conducted on the Pleasant River found that 31 of 707 smolt had their origins in a commercial hatchery upstream.[57] Presumably these escapees would be among the most likely to interbreed with wild salmon because Atlantic salmon return to their natal rivers to spawn.

Salmon remain at sea from one to three years before returning to freshwater to spawn.[58] During their time at sea, Atlantic salmon undertake long migrations; marked salmon of North American origin regularly travel as far as Greenland and some have been taken in Scottish waters on the other side of the Atlantic Ocean.[59] Adults returning to freshwater after having spent only one year at sea are known as grilse.[60] Adults returning to freshwater after having spent two to four years at sea are known as salmon.[61] The spawning migration of Atlantic salmon upriver is well-known. However, Atlantic salmon differ from Pacific salmon, around which a great deal of the popular understanding of salmon life cycles in general has been formed, in that they do not necessarily die after spawning. Spent Atlantic salmon are known as kelts, and may return to the sea to pass one or more years before ascending freshwater rivers to spawn again.[62]

C. *The Value of Atlantic Salmon*

Most of the exploitation of remaining wild Atlantic salmon stocks and the impetus for the creation and continued growth of the Atlantic salmon mariculture industry has been for food. The majority of farmed Atlantic salmon have historically been sold as fresh fillets, although the industry is now moving towards "value-added Atlantic salmon products aimed at meeting time-pressed consumers increasing demand for convenience," such as frozen fillets and vacuum-marinated plastic packs.[63] Atlantic

56. *Id.*

57. *Id.*

58. U.S. ATL. SALMON ASSESSMENT COMM., *supra* note 16, at tbl. 3.2.b. Salmon returning to rivers from the sea are classified as one, two, or three sea-winter fish meaning that they have spent one, two, or three years at sea.

59. MILLS, *supra* note 44, at 46–52.

60. *Id.* at 9.

61. *Id.* at 9–11.

62. *Id.*

63. *See* Steven Hedland, *November 2003 Species Focus: Atlantic Salmon, Growth Hinges on the*

salmon mariculture operations help to alleviate pressure on wild salmon stocks by providing an alternative source of salmon to catch fisheries. The reduction of pressure on wild salmon for food is a positive effect of Atlantic salmon mariculture operations and must be weighed against the negative effects of salmon farming.

In 1653, Izaak Walton, the best-known early fishing author, described the Atlantic salmon as "the king of freshwater fish."[64] For many dedicated fly-fishermen, and others concerned with the plight of Atlantic salmon, that designation is as true today as it was then.[65] The pursuit of Atlantic salmon is an expensive proposition and can be an important source of revenue for local communities where it can be sustained. However, in both the United States and Canada, sport fishing of Atlantic salmon has occasionally been allowed to continue on specific salmon stocks depleted beyond the point of commercial profitability.[66]

Ted Williams, the recently deceased Boston Red Sox baseball star, was an avid Atlantic salmon fisherman for much of his life and an outspoken advocate of salmon conservation.[67] The Atlantic salmon is one of the most cherished symbols of the wild and clean rivers. This positive image has helped to stimulate current salmon preservation efforts and will continue to play a role in the future management of the

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Farmed-Salmon Industry's Ability to Produce and Market Winning Value-Added Products, *available at* http://www/seafoodbusiness/com/archives/02nov/11atlanticsalmon.htm.

64. IZAAK WALTON, *The Compleat Angler or The Contemplative Man's Recreation: Being a Discourse of Fish and Fishing Not Unworthy the Perusal of Most Anglers*, *in* THE SALMON 174 (Andrew Lang ed., J.M. Dent & Co. 5th ed. 1676).

65. The term "king of fish" has proven to be remarkably persistent with reference to Atlantic salmon, indeed to such a degree that a reference to Atlantic salmon as the "king of fish" at times seems almost obligatory in the popular literature. *See, e.g.*, Michael Forsyth, *King of Fish in Deep Water Without Will to Protect Native Asset*, SCOTLAND ON SUNDAY, Apr. 6, 2003; L. Ian MacDonald, *In Pursuit of the King of Fish*, THE GAZETTE (Montreal), July 31, 2002; John Vidal, *Stocks of Wild Atlantic Salmon at Record Low*, THE GUARDIAN (London), June 1, 2001; James Freeman, *The Future of Wild Atlantic Salmon at Risk*, THE HERALD (Glasgow), June 1, 2001; Cahal Milmo & Elizabeth Nash, *Fish Farms Push Atlantic Salmon Towards Extinction*, THE INDEPENDENT (London), June 1, 2001; Brian Clarke, *SOS Goes OUT- Save Our Salmon*, THE TIMES (London), Aug. 3, 1998.

66. For example, Maine's 1996 Atlantic Salmon Fishing Regulations permitted catch and release fly fishing for Atlantic salmon on the Dennys, Machias, East Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot rivers. *See* ME. ATL. SALMON TASK FORCE, ATLANTIC SALMON CONSERVATION PLAN FOR SEVEN MAINE RIVERS (1997), *available at* http://www.state.me.us/asa/ascpall.htm. The total documented number of Atlantic salmon returning to spawn in those rivers in 1996 was several dozens of fish. *See* U.S. ATL. SALMON ASSESSMENT COMM., *supra* note 16, at tbl. 3.2.b.

67. *See, e.g.*, Tony Chamberlain, *Boatload of Talent Extended to Another Sport*, BOSTON GLOBE (July 5, 2002); Philip Lee, *MSA honors "Teddy Baseball,"* 49(1) ATL. SALMON J 21 (2000), *available at* http://www.asf.ca/Journal/2000/spr00/sp00cnbk/nb100.html.

salmon. Restoration of the Atlantic salmon to areas of its former range where it was extirpated has generated a great deal of interest and effort on the part of both the federal and state governments.[68] At present, no sport fishing for Atlantic salmon is allowed in Maine in order to protect the endangered Gulf of Maine D.P.S.[69]

D. *The Growth of Aquaculture and Salmon Mariculture Production in the United States and Its Impact*

Aquaculture production[70] is increasing everywhere on earth, with the exception of Africa and the countries of the former Soviet Union.[71] From 1988 to 1997, total global aquaculture production more than doubled, in terms of both weight and value.[72] From 1988 to 1997, aquaculture production increased from 15% to 28% of the total global seafood supply.[73] The global per capita availability of aquaculture products increased from 2.3 to 6.4 kilograms per year from 1984 to 1997.[74]

Aquaculture production has increased steadily in the United States over the past decade and is projected to continue growing in the near future, both in terms of absolute poundage and as a percent of total U.S. seafood consumption.[75] North American aquaculture production increased an average of 3.6% per year from 1984 to 2001, as compared to the global average of 9% per year over the same time period.[76]

68. *See, e.g.*, Tony Chamberlain, *Journeying the Connecticut River Taking Stock of Salmon*, BOSTON GLOBE (July 22, 1997), *available at* http://www.boston.globe/sports/packages/conn_river/partthree.htm.

69. *See, e.g.*, Me. Atl. Salmon Comm'n, *2003 Open Water Fishing Regulations* (Apr. 18, 2003), *available at* http://www.state.me.us/ifw/fishing/2003openwaterlaws.htm#MAINE%20ATLANTIC%20SALMON%20COMMISSION ("It is unlawful to angle, take, or possess anadromous Atlantic salmon from all Maine waters (including coastal waters)). Any salmon incidentally caught, must be released immediately, alive and uninjured. At no time should Atlantic salmon be removed from the water. The number of adult anadromous Atlantic salmon returning from the sea to spawn in Maine waters is very low, and sport fisheries were suspended in December of 1999. Some areas where adult Atlantic salmon congregate have been closed to fishing for all species"). More information on the current state of regulations can be obtained at the homepage of the Maine Atlantic Salmon Commission. http://www.state.me.us/asa/.

70. *See* GOLDBURG ET AL., *supra* note 1, at iii.

71. Senu S. De Silva, *A Global Perspective of Aquaculture in the New Millennium*, 431 TECHNICAL PROC. OF THE CONF. ON AQUACULTURE IN THE THIRD MILLENNIUM 20–25 (2000).

72. GOLDBURG ET AL., *supra* note 1, at ii.

73. De Silva, *supra* note 71, at 434.

74. *Id.*

75. GOLDBURG ET AL., *supra* note 1, 2–5.

76. Paul G. Olin, *Current Status of Aquaculture in North America*, *in* AQUACULTURE IN THE THIRD MILLENNIUM, 431 TECHNICAL PROC. OF THE CONF. ON AQUACULTURE IN THE THIRD

Although the increase in North American and United States production has not been as rapid as the overall increase in global production,[77] North American consumers drive a disproportionate amount of aquaculture production in other countries. The United States is eleventh in aquaculture production but third in seafood consumption, which necessitates the importation of large amounts of fish each year.[78]

In North America, mariculture production[79] has increased over the past two decades not only in terms of weight and value, but also as a percentage of overall aquaculture production.[80] From 1988 to 1997, North American mariculture production increased from 45,000 to 209,000 metric tons, while freshwater aquaculture production increased from 233,000 to 315,000 metric tons over the same time period.[81] Thus, mariculture, which in 1988 represented a little less than one quarter of total North American aquaculture production, had grown by 1997 to represent a little more than two-fifths of total North American aquaculture production.

When we narrow our focus further and consider Atlantic salmon mariculture, we find that it is increasing worldwide, especially in the United States. In both arenas, Atlantic salmon mariculture growth has been explosive. From 1984 to 1999, the value of worldwide Atlantic salmon mariculture grew from slightly more than $150 million in U.S. dollars to almost $2.5 billion, an increase of nearly 1,600%.[82] From 1989 to 1999, Atlantic salmon mariculture by weight increased by 595 percent in the U.S.[83] This increase in Atlantic Salmon mariculture in part reflects a shift in focus on the part of aquaculture producers from species low on the food chain to carnivorous species such as the Atlantic salmon, which tend to bring much higher prices in the market.[84]

The global increase in aquaculture and mariculture production has been and will continue to be driven by an increased demand for seafood worldwide in the face of dwindling stocks of wild fish. With the

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MILLENNIUM 377 (2000).

77. GOLDBURG ET AL., *supra* note 1, at 2.

78. *Id.*

79. *Id.* at iii.

80. Based on Food & Agriculture Organization dataset. *See Aquaculture Production: Quantities 1950–2001*, *available at* http://Ftp.fao.org/fi/stat/windows/fishplus/aquaq.zip.

81. *Id.*

82. *Id.* The figure cited includes Atlantic salmon classified as produced either by mariculture or brackish water.

83. *Id.*

84. GOLDBURG ET AL., *supra* note 1, at 2.

exception of China, which has dramatically increased per-capita fish supply domestically since 1980, world per-capita fish supply has remained relatively stable since the mid-1980s.[85] Over the second half of the last century, however, world landing statistics for capture fisheries grew steadily from 1950 to 1969, continued to grow through the 1970s and 1980s, albeit at a slower rate, and then leveled off during the 1990s, with total landings presently varying from 85 to 95 million metric tons per year.[86] This leveling off of the catch is thought to represent the near complete exploitation of the most important fish stocks worldwide.[87]

As the population of the world and consequent demand for seafood continues to grow, it unlikely that the pressure on already depleted fish stocks will lessen. Therefore, it is the opinion of many national and state governments that an ever-greater future demand for seafood can only be met through increased aquaculture, which in turn has made these governments strong advocates of increasing aquaculture. In the United States, state and federal government advocacy has played and will continue to play an important role in aquaculture development. Moreover, aquaculture is viewed not only as a solution to the seafood shortage but also as an attractive source of revenue and employment. For example, in Maine, the center of the U.S. Atlantic salmon mariculture industry, aquaculture operations generate annual revenues of nearly $70 million.[88] Atlantic salmon mariculture alone generates annual revenues of nearly $18 million and provides nearly 700 jobs in two Maine counties.[89] Overall, the Maine aquaculture harvest of finfish grew thirty-

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85. FOOD & AGRIC. ORG. OF THE UNITED NATIONS, THE STATE OF WORLD FISHERIES AND AQUACULTURE (2000) [hereinafter STATE OF WORLD FISHERIES AND AQUACULTURE].

86. *Id.*

87. *Id.*

88. ME. STATE PLANNING OFFICE, MAINE COASTAL PLAN, FINAL ASSESSMENT AND STRATEGY UNDER SECTION 309 OF COASTAL ZONE MANAGEMENT ACT 28, *available at* www.maine.gov/mcpldownloads/309_reports/309_assessment_april01.pdf (Last visited July 27, 2003).

89. *Id.* In spite of the jobs provided by the Atlantic salmon mariculture industry, both Hancock and Washington counties had unemployment rates higher in 2001 than the Maine statewide average of 4%. *See* ME. DEP'T OF LABOR, DIV. OF LABOR MKTG. INFO. SERV., 2001 CIVILIAN LABOR FORCE ESTIMATES FOR MAINE AND MAINE COUNTIES, BY MONTH AND ANNUAL AVERAGE, *available at* http://www.maine.gov/labor/lmis/data/laus/mecty01.html (last visited Dec. 12, 2002) (in cooperation with the U.S. Bureau of Labor Statistics). The unemployment rate in Hancock County was 4.5% while the unemployment rate in Washington County was more than double the statewide average at 8.1%. *Id.* In addition, in 1999 the per-capita income in Washington County was $19,098, or $5,122 below the statewide average of $24,220 (2000 figures not yet available). *See* ME. DEP'T OF LABOR, PER CAPITA PERSONAL INCOME IN THE UNITED STATES, NEW ENGLAND, MAINE, AND COUNTIES, 1981–2001, *available at* http://www.maine.gov/labor/lmis/data/laus/pcincome.html (Sept. 2002) (based on U.S. Dep't of

six-fold from 1988 to 2000, from one million pounds in 1988 to over thirty-six million pounds in 2000.[90] In light of these statistics from the most productive aquaculture states, together with continued predictions of shortages in world capture fisheries, it is not surprising that the United States Department of Commerce is promoting a five-fold increase in U.S. aquaculture production by the year 2025.[91]

However, aquaculture, and in particular Atlantic salmon mariculture, will not be able to develop further in state and federal waters without successfully negotiating a variety of environmental, social, political, and technological obstacles that affect both the public perception and economic viability of aquaculture operations. Atlantic salmon mariculture releases effluents and contaminants that are difficult to monitor and control, and tends to provoke high-profile conflicts over water use. Atlantic salmon are high on the food chain and require environmentally damaging accessory fisheries. These problems will be exacerbated as Atlantic salmon mariculture becomes an increasingly important segment of overall U.S. aquaculture.[92]

Atlantic salmon mariculture is primarily the province of large international corporations and thus has a comparatively large reserve of funding for research and development. The current regulatory framework for aquaculture is characterized by a patchwork of state and federal laws that was not conceived of with aquaculture in mind. With no agency clearly designated as the lead federal agency, no one has devised a clear blueprint detailing exactly how a prospective aqaculturalist is to navigate the maze of regulations. For example, the

Commerce, Bureau of Economic Analysis statistics). Per-capita income in Hancock County in 1999 was $25,749, or $1,529 above the statewide average. *Id.* These statistics are not presented in an attempt to show that employment in the Atlantic salmon mariculture industry does not help to mitigate unemployment in Maine, but rather to suggest that since the unemployment rate in these two counties would undoubtedly be higher in the absence of the Atlantic salmon mariculture industry, the State of Maine has a strong vested interest in supporting the industry in the face of environmental and other challenges.

90. ME. DEP'T OF MARINE RES., AQUACULTURE LEASE INVENTORY xiv, *available at* http://www.maine.gov/dmr/aquaculture/Index%20Pages.pdf (June 2001).

91. *See* GOLDBURG ET AL., *supra* note 1, at 3–4.

92. Compare Atlantic salmon mariculture with catfish farming, which historically has been the most important segment of U.S. aquaculture. Catfish are low on the food chain and do not require high-protein fish meal to grow, and therefore do not require high-impact accessory fisheries to provide a source of high-quality protein. In addition, effluent from catfish ponds can be contained and controlled relatively easily in comparison to effluent originating from other types of fish containment structures. Moreover, catfish ponds do not tend to provoke high-profile conflicts over land use. These positive attributes of catfish farming have tended to minimize the overall environmental and social impact of U.S. aquaculture to this point in time.

primary regulatory authority to control pests in aquaculture is given to the United States Department of Agriculture under the 2002 Farm Bill, in which Congress defined the term "livestock" broadly to include "all farm-raised animals,"[93] while the United States Environmental Protection Agency (EPA) regulates effluents from aquaculture facilities.[94] Despite the potential environmental and other problems associated with expanded Atlantic salmon mariculture, the most important question currently surrounding Atlantic salmon mariculture (and other types of mariculture with the potential to harm the marine environment) is not whether these types of mariculture should be promoted and developed. Indeed, given the current global seafood shortage and the profitability and financial backing of certain segments of the mariculture industry, it seems inevitable that they will. Rather, the question currently garnering attention is: in which areas of the sea should development take place and under what regulatory framework?

The decrease in wild Atlantic salmon in U.S. waters that led to their endangered species listing[95] coincided with a massive influx of introduced Atlantic salmon to wild Atlantic salmon habitat from two sources: Atlantic salmon stocking programs and the Atlantic salmon mariculture industry. The introduction of stocked fish was by definition intentional, with the intent of bolstering wild Atlantic salmon populations.[96] The escape of mariculture industry fish occurred either through "leakage"—the industry term for the escape of small numbers of fish during normal operations—or, in extremely large numbers, through catastrophic events. For example, in December 2000, roughly 100,000 Atlantic salmon of non-North American origin escaped from a salmon net pen at Stone Island off the coast of Maine.[97] In a separate incident in November 2000, 13,100 Atlantic salmon escaped from another net pen

93. *See* Animal Health Protection Act, Pub. L. No. 107-171, § 10403(10), 116 Stat. 134 (2002).

94. *See infra* Part III.

95. *See infra* Part IV.

96. Curiously, stocking Atlantic salmon may not only not have bolstered numbers of wild fish, it also may have contributed to their decline. An analysis of the number of Atlantic salmon stocked in U.S. waters against the number of Atlantic salmon returning to spawn shows that (over the length of the data set from the late 1960s to 1999) as the overall number of Atlantic salmon stocked in U.S. waters increased, the count of salmon returning to spawn decreased. A statistical analysis (the Spearman correlation coefficient) of the data reveals a statistically significant *negative* correlation between the number of salmon stocked and returns. To date, little attention has been focused on the effects of Atlantic salmon stocking programs on wild populations of salmon.

97. U.S. Pub. Interest Research Group v. Atl. Salmon of Me., LLC, 215 F. Supp. 2d 239, 243 (D. Me. 2002) (order affirming recommended decision; recommended decision by Mag. Kravchuk).

off the Maine coast.[98] The loss of Atlantic salmon from net pens is apparently routine in the mariculture industry. Heritage Salmon, a mariculture company, lost 90,359 fish between 1994 and 1998, although not all of those fish were escapees.[99] When these numbers are compared to the numbers of wild fish returning to spawn, it is easy to see why a great deal of concern has been focused on the impact of mariculture escapees on wild Atlantic salmon.

As elucidated below, Atlantic salmon mariculture operations are a point source of pollutants to navigable waters, which of course includes salmon habitat. The pollutants include copper (an ingredient in antifouling preparations used to prevent the growth of marine algae on salmon pens); feed (which includes biological wastes from the chicken industry as well as added pigments to color the salmon flesh); several diseases, viruses, and parasites including bacterial kidney disease, funrunculosis, hitra, vibrios, and infectious salmon anemia; fish wastes; chemicals including antibiotics added to feed and biocides designed to kill fish lice; and Atlantic salmon escapees.[100]

The effect of escapees on wild Atlantic salmon is different than the effect of traditional pollutants. Not only may escapees directly compete with wild Atlantic salmon for food and habitat,[101] but more importantly, escapees have the potential to dilute the genetic material of the wild stock. Although a strong wild salmon population might well support the introduction of a limited amount of foreign genetic material into the gene pool, a threatened population could be overwhelmed by the same influence.[102] The number of wild Atlantic salmon in the Gulf of Maine D.P.S. returning to spawn in recent years has been extremely low, perhaps several dozens or several hundreds of fish,[103] while the number of escaped salmon from mariculture operations has been as high as 100,000 in a single incident.[104]

98. U.S. Pub. Interest Research Group v. Heritage Salmon, Civ. No. 00-150-B-S, 2002 U.S. Dist. LEXIS 2706, at *10 (D. Me. Feb. 20, 2002) (recommended decision by Mag. Kravchuk).

99. *Id.*

100. *See infra* notes 149–50 and accompanying text.

101. Introduced exotic species present a similar concern. *See supra* note 42.

102. *See* MILLS, *supra* note 44, at 270.

103. Endangered and Threatened Species; Final Endangered Statute for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,461, 69,468 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 17).

104. U.S. Pub. Interest Research Group v. Atl. Salmon of Me., LLC, 215 F. Supp. 2d 239, 243 (D. Me. 2002).

Escaped salmon from net pens also may attempt to enter rivers and spawn. In fact, Atlantic salmon escapees from net pens in the Pacific Northwest, where they have never been native, have spawned successfully in British Columbia, prompting fears that they will colonize traditional Pacific salmon waters.[105]

Although Salmon mariculture in British Columbia also uses other species of salmon, about seventy percent of all salmon mariculture in British Columbia is based on Atlantic salmon stocks.[106] The government of British Columbia is currently promoting an increase in salmon mariculture and has stated that it will "begin accepting applications for new finfish aquaculture sites" starting in 2002.[107] The number of such sites currently permitted is 121.[108] In British Columbia, environmentalists and others have expressed concern about the impact of escaped Atlantic salmon on Pacific salmon stocks. Perhaps to the envy of east coast fisheries scientists, who have poured tens of millions of dollars into programs to restore the Atlantic salmon to the Connecticut, the Merrimack, and other New England rivers with little success, Atlantic salmon, with little encouragement, seem to be in the process of establishing itself in British Columbia as mariculture escapees successfully breed in British Columbia rivers.[109] While this would be considered a rousing success in Connecticut (assuming native populations were used), it has the potential to be an unmitigated disaster on the west coast, where Pacific salmon are already in severe decline due to overfishing and habitat destruction, among other causes.

E. Stocking of Native and Exotic Fish and Their Impacts

Although the idea of native fish as pollutants would be a new paradigm in fisheries management, the idea that introductions of exotic fish are potentially harmful is not new. The history of U.S. fisheries management is rife with examples of exotic fish species wreaking havoc with ecosystems, even when those exotic fish were intentionally introduced in an attempt to correct a perceived imbalance in the original

105. JOHN VOLPE, SUPER-UNNATURAL, ATLANTIC SALMON IN BC WATERS 53 (2001), *available at* http://www.davidsuzuki.org/files/Super_Un_Natural.pdf.

106. DAVID SUZUKI FOUND., WHY YOU SHOULDN'T EAT FARMED SALMON (2002), *available at* http://www.davidsuzuki.org/files/PSF_Salmon_Brochure.pdf.

107. GOV'T OF B.C., MINISTRY OF AGRIC., FOOD & FISHERIES, SALMON AQUACULTURE POLICY FRAMEWORK (2002), *available at* http://www.agf.gov.bc.ca/fisheries/salmon_aqua_policy.htm.

108. *Id.*

109. VOLPE, *supra* note 105, at 18–20.

ecosystem or to improve fisheries.[110] Some well-known examples include the common carp and the brown trout, both of which are now widespread throughout the United States and have altered or appropriated for themselves habitat which was previously available to native fishes; sea lampreys in the Great Lakes, which caused the complete collapse of lake trout stocks throughout the Great Lakes; and the walking catfish in Florida, which has crowded out native fishes locally and caused losses through predation in tropical fish farms.[111]

In many cases the introduction of exotic species has been accidental, in other cases it resulted from intentional stocking. The common carp and brown trout are examples of release through intentional stocking. Both fish were widely stocked in U.S. waters over the past two centuries. Brown trout are still commonly stocked as a part of many state fishery management programs. Introductions of both common carp and brown trout to waters where they are not native are viewed as beneficial in many instances because they provide sport fishing where native species no longer exist or are reduced in numbers due to environmental factors, in the case of the brown trout, or as a food fish, in the case of the carp.[112] However, they also may contribute to the decline of native fishes through competition and other factors[113] as well as give a false sense of security regarding water quality because they are able to survive in waters which are unfit for native species. The carp is legendary for its ability to survive in severely degraded urban waterways, while the brown trout is the hardiest of the commonly stocked and fished trout species in the United States;[114] it is the most resistant to the higher water temperatures, which commonly result from clearing riverbanks and subsequent loss of shade. Thus, carp and brown trout can provide fishing where no fishing exists for brook trout, cutthroat trout, and rainbow trout because of poor water quality.

Therefore, a fundamental question in fisheries management is whether aquatic ecosystems should be managed for fish that are

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110. S.R. Hall & E.L. Mills, *Exotic Species in Large Lakes of the World*, 3 AQUATIC ECOSYSTEM HEALTH & MGMT. 105, 110, 113–14 (2000).

111. *See* Univ. of Fla., Center for Aquatic and Invasive Plants, *at* http://aquat1.ifas.ufl.edu/mcfish5d.html (last visited July 27, 2003).

112. Jeffrey N. Taylor et al., *Known Impacts of Exotic Fishes in the Continental United States*, *in* DISTRIBUTION, BIOLOGY, & MANAGEMENT OF EXOTIC FISHES 323, 323–24 (Walter R. Courtenay, Jr. et al. eds., 1984); Walter R. Courtenay, Jr. et al., *Distribution of Exotic Fishes in the United States*, *in* DISTRIBUTION, BIOLOGY, & MANAGEMENT OF EXOTIC FISHES 49.

113. Taylor et al., *supra* note 112, at 322–23.

114. *Id.* at 323.

relatively unaffected by degraded water quality or whether the focus should be on improving water quality to the point where native fish that historically were dominant in the habitat are once again abundant. In general, the trend in fisheries management is increasingly to exercise caution where the introduction of exotic fishes is concerned. Exotic fish introductions are no longer viewed as a panacea for all of the fisheries challenges that degraded waterways present. In fact, as the recent clamor over the accidental introduction of the snakehead into a Crofton, Maryland pond demonstrates, the introduction of exotic fish is often feared because it has the potential to disrupt and even destroy native ecosystems.[115] Thus, even though the word "pollutant" is rarely used to describe such exotic fish introductions as that of the snakehead in Maryland, many fisheries managers already essentially manage exotic fish as pollutants.

The impacts of native fishes stocked for sports fishing on wild fish of the same species are essentially the same as the impacts of Atlantic salmon mariculture escapees on wild salmon—that is, the introduction of exotic species or varieties of fish to new bodies of water, genetic contamination of the wild genome, predation on wild fish, competition with wild fish for food and favorable space, disruptive behavior, stimulation of premature migrations, the creation of unacceptably high densities of fish, mixed-stock exploitation problems, predator attraction, and disease and parasite transmission.[116] The American Fisheries Society categorizes the impacts of exotic species into five classes: habitat alteration, spatial alteration, trophic alteration, gene pool deterioration, and introduction of diseases.[117] Of these classes, gene pool alteration is perhaps the least serious problem in the case of introduced exotic fishes because there is little chance that exotic fish will be able to breed with native fishes. However, gene pool alteration may be one of the most serious effects of the contamination of native fishes by their own genetically distinct relatives.

Exotic fish species are seen as either a boon or a boondoggle depending on the species and the evaluator. Their positive aspects include the creation of fisheries in waters where native fishes are no

115. *U.S. Wants Snakehead Imports Banned*, *available at* http://www.cnn.com/2002/TECH/science/07/23/snakehead.classification/?related (last visited July 20, 2003).

116. Ray J. White et al., *Better Roles for Fish Stocking in Aquatic Resource Management, Uses and Effects of Cultured Fishes in Aquatic Ecosystems*, 15 AM. FISHERIES SOC'Y 527, 533 (1994).

117. C.C. KOHLER ET AL., AM. FISHERIES SOC'Y POSITION ON INTRODUCTIONS OF AQUATIC SPECIES, *available at* http://www.afsifs.vt.edu/afspos.html (2002).

longer abundant because of degraded water quality. This is the case with the German brown trout, which, because it is more tolerant of warm water and pollution than brook trout, provides wild, although not native, trout fishing in many eastern rivers that are no longer suitable for brook trout. However, the negative aspects of exotic species introductions include the displacement or reduction in numbers of native species from waterways that are still suitable for native species.

A number of exotic species have been introduced throughout the former range of the Atlantic salmon in North America and have established self-sustaining populations. These included the German brown trout, a European species, and the rainbow trout, from the American west. A great deal of concern has been expressed about the ability of young Atlantic salmon to successfully compete in particular with rainbow trout.[118] All salmon and trout are closely related and the parr stage of the Atlantic salmon so closely resembles a trout and inhabits such similar habitats that for many years it was not recognized as the young of the Atlantic salmon but rather described as a species of trout.[119] Introduced exotic trout species will undoubtedly compete with young Atlantic salmon for habitat and may replace juvenile salmon in certain habitats.[120] Similarly, escaped parr and smolts from hatcheries that provide feedstock for Atlantic salmon mariculture operations also may compete with and displace juvenile salmon. Hatchery fish often learn or are even bred to display aggressive feeding behaviors that result in fast growth rates. These hatchery fish might out-compete wild fish in certain situations, with no hope of later completing the salmon life cycle.

F. Accidental and Intentional Releases of Fish

The two principal avenues of release into U.S. waters that are followed by native species are the same for exotic species, i.e. intentional stocking programs and accidental release.[121] Accidental releases include the moving of fish from one waterway to another via fishermen's bait buckets, the effects of floods, or the water in live wells in sports fishing vessels. Although undesirable, such introductions are difficult to monitor and regulate. On the other hand, a second category of accidental releases, that includes the escape of juvenile and adult fish

118. MILLS, *supra* note 44, at 263–65.
119. *Id.* at 7–9.
120. *Id.* at 263–65.
121. *See supra* notes 110–15 and accompanying text.

from hatcheries and mariculture operations, are more easily controlled through bio-security measures and escape response planning. Intentional releases include the release of stocked fish for recreational fisheries and the release of aquaculture specimens "if they are not growing rapidly enough to justify continued feeding."[122] Neither of these two forms of intentional releases are monitored or regulated, although they could be.[123] While the release of intentionally stocked fish can have negative results on wild fish populations, unfortunately at present such releases are generally viewed in a positive light because they are tightly linked to sales of fishing licenses and private sector facets of the sport fishing economy. Indeed, the EPA has identified approximately 500 state fish hatcheries and cites a study of state coldwater fishery programs that indicates that those programs distributed 23.7 million pounds of trout and salmon from state hatcheries in 1996 alone.[124] Yet, because the intentional release of stocked fish and the release of the second category of accidental fish release originate from "point sources,"[125] they fall within the EPA's mandate to regulate their discharge under the Clean Water Act National Pollutant Discharge Elimination System program, if such discharges encompass the discharge of "pollutants."

III. THE LEGAL REGIME REGULATING THE DISCHARGE OF POLLUTANTS FROM MARICULTURE FACILITIES

A. *Framework*

In 1972, Congress enacted the Federal Water Pollution Control Act.[126] Now known as the Clean Water Act (CWA or the "Act"),[127] the Act prohibits the discharge of a pollutant from a point source to the waters of the United States without a National Pollutant Discharge Elimination

122. Effluent Limitation Guidelines and New Source Performance Standards for the Concentrated Aquatic Animal Production Point Source Category, 67 Fed. Reg. 57,872, 57,877 (proposal Sept. 12, 2002) (to be codified at 40 C.F.R. pt. 451.35(c)).

123. The EPA is seeking comment on the efficacy of banning such intentional releases. *Id.*

124. *Id.* at 57,876, 57,903. The federal government and native American tribes manage additional fish hatcheries.

125. The term "point source" means any "discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged." 33 U.S.C. § 1362(14) (2000).

126. Pub. L. No. 95-217, 91 Stat. 1566 (1977).

127. 33 U.S.C. §§ 1251–1387 (2000).

System (NPDES) permit.[128] NPDES permits mandate compliance with technology-based effluent limitations and state water quality standards. To the extent that a person wishes to discharge effluents to the territorial sea,[129] contiguous zone or ocean, section 403 of the CWA[130] requires that the discharge also must be in compliance with any ocean discharge criteria adopted by the EPA.[131] These criteria are primarily directed at protecting the ecological health of the marine environment.[132] As of

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128. *Id.* § 1311; *see also* 22 U.S.C. §§ 1342, 1362(12); Int'l Paper v. Ouellette, 479 U.S. 481, 489 (1987); USEPA v. Cal. ex rel. State Water Res. Control Bd., 426 U.S. 200, 205 (1976).

129. The territorial sea is defined for the purposes of the CWA as within three nautical miles of the shore. 33 U.S.C. § 1362(8). The CWA has not been amended to bring it into line with President Reagan's Proclamation that extended the territorial sea to 12 nautical miles. *See* Proclamation No. 5928, 54 Fed. Reg. 777 (Jan. 9, 1989), 3 C.F.R. 5928 (1988) *reprinted in* 43 U.S.C. § 1331; *see also* United Nations Law of the Sea Convention, art. 3, 1833 U.N.T.S. 3, *available at* http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm (Dec. 10, 1982). Although the United States has not yet ratified the Law of the Sea Convention, a twelve nautical mile territorial sea is likely supported by customary international law as well. The territorial sea definition in the CWA is not entirely consistent with the Submerged Lands Act (SLA) either. 43 USC §§ 1301(a) (2000) *See* Natural Res. Def. Council, Inc. v. U.S.E.P.A., 863 F.2d 1420, 1434–36 (9th Cir. 1988). The SLA, which was adopted after the U.S. Supreme Court ruled in *United States v. California*, 332 U.S. 19, 34 (1947), that the federal government rather than state governments held title to lands beneath the sea from the tidelands to three nautical miles, granted to the states title to these lands or to any further boundary as its existed at the time of statehood. Subsequent litigation resulted in Texas and Florida (Gulf Coast only) being awarded title to submerged lands extending three marine leagues (about nine nautical miles). *See, e.g.*, United States v. Florida, 420 U.S. 531 (1975). For a view of the federal government's present position on jurisdictional boundaries, see Territorial Seas, Navigable Waters, and Jurisdiction, 67 Fed. Reg. 52,906, 52,906–13 (proposal Aug. 14, 2002) (to be codified at 46 C.F.R. pts. 7 & 28).

130. 33 U.S.C. § 1343.

131. Regulations implementing section 403 are found at Criteria and Standards for the National Pollutant Discharge Elimination System, 40 C.F.R. § 125.120–.124 (2003). *See also* Ocean Discharge Criteria, 45 Fed. Reg. 65,942 (Oct. 3, 1980) (to be codified at 40 C.F.R. pt. 125). In the waning days of the Clinton Administration, the EPA announced proposed revisions to Ocean Discharge Criteria and sent a proposed rule to the Office of the Federal Register. USEPA OFFICE OF WATER FACT SHEET, REVISIONS TO CLEAN WATER ACT OCEAN DISCHARGE CRITERIA REGULATIONS, EPA-842-F-01-001 (Jan. 2001). However, the proposed rule was not published in the Federal Register prior to the onset of the Bush Administration, and thus, on January 20, 2001, the Bush Administration "withdrew" the proposal to give the new EPA Administrator "an opportunity to review it." *Id.*; Memorandum for the Heads and Acting Heads of Executive Departments and Agencies, 66 Fed. Reg. 7701, 7701–02 (Jan. 24, 2001). *See National Legal Center for the Public Interest*, Judicial Legislative Watch Report, 1 (Feb. 2003), *available at* http://www/nlcpi/org/books/pdf/jlwr_march01.pdf. To date, the proposed rule as developed by the Clinton EPA (or for that matter, any modification thereof) has not been published in the federal register.

132. 40 C.F.R. § 125.122(a) (protecting against "unreasonable degradation of the marine environment").

September 2001, 250,000 facilities nationwide were regulated under NPDES permits.[133]

Although Congress designated the EPA to administer the CWA, a state may apply to manage its own program in lieu of the federal program.[134] The EPA Administrator, who manages such applications, is required to approve the state application if: 1) the proposed state program is at least as stringent as the federal program; and 2) the state has adequate legal authority to carry out the program, to monitor and ensure compliance therewith, and to abate and deter violations through the imposition of civil and criminal penalties and other means of enforcement.[135]

Even in the case of a state-delegated program, however, the EPA retains the right, subject to waiver, to review individual permits,[136] to commence an enforcement action seeking compliance with the CWA, and to require the imposition of administrative, civil judicial and criminal penalties for violations thereof.[137] Additionally, in those instances when the EPA and, if delegated authority, the state having jurisdiction over the discharge, fails to undertake action to enforce compliance with the CWA, Congress authorized individual private citizens to enforce the Act through litigation.[138]

B. USPIRG Cases

In the State of Maine, the EPA had the authority to issue NPDES permits until January 2001, when that authority was assumed by the State of Maine.[139] Although the EPA indicated as early as 1988 that floating net pen facilities used for salmon mariculture in state

133. U.S. ENVTL. PROT. AGENCY (USEPA), AQUATIC NUISANCE SPECIES IN BALLAST WATER DISCHARGES: ISSUES AND OPTIONS, DRAFT REPORT FOR PUBLIC COMMENT 31 (2001).

134. 33 U.S.C. § 1342(b)–(c) (2000).

135. *Id.* § 1342(b).

136. *Id.* § 1342(d)–(e).

137. 33 U.S.C. § 1319(a)–(d), (g). For analysis of how the EPA chooses among administrative, civil judicial, and criminal enforcement, see Jeremy Firestone, *Agency Governance and Enforcement: The Influence of Mission on Environmental Decision Making*, 21 J. POL. ANALYSIS & MGMT. 409, 426 (2002) (enforcement against individual violators); Jeremy Firestone, *Enforcement of Pollution Laws and Regulations: An Analysis of Forum Choice*, 27 HARV. ENVTL. L. REV. 105, 147–59 (2003) (enforcement against firms and governmental entities).

138. 33 U.S.C. § 1365; Profitt v. Rohm & Hass, 850 F.2d 1007, 1011 (3d Cir. 1988) (noting that a citizen suit operates as an "alternative enforcement mechanism" in the face of "inert" government action) (internal citations omitted).

139. U.S. Pub. Interest Research Group v. Heritage Salmon, Civ. No. 00-150-B-S, 2002 U.S. Dist. LEXIS 2706, at *10 (D. Me. Feb. 20, 2002) (recommended decision by Mag. Kravchuk).

jurisdictional waters off the coast of Maine may require NPDES permits,[140] no NPDES permit was issued for any such facility. As a result, on July 31, 2000, the United States Public Interest Research Group (USPIRG) and several individual plaintiffs filed separate lawsuits against Heritage Salmon, Inc. (Heritage Salmon),[141] Atlantic Salmon of Maine, LLC (Atlantic Salmon),[142] and Stolt Sea Farm, Inc. (Stolt)[143] alleging in each case that the defendant had discharged pollutants to the U.S. waters in violation of the CWA at the defendant's Maine salmon farm (hereinafter jointly referred to as the "USPIRG cases").[144]

In order to prevail on such a claim, USPIRG is required to establish that "five elements exist: '(1) a pollutant must be (2) added (3) to navigable waters (4) from (5) a point source.'"[145] Because the focus of this article is on the notion of fish as pollutants, we focus on the first criterion—pollutants.[146] Under the CWA, the term "pollutant" is defined

140. *Id.* at *7–11.

141. *Id.* at *1–2.

142. U.S. Pub. Interest Research Group v. Atl. Salmon of Me., LLC, 215 F. Supp. 2d 239, 243 (D. Me. Feb. 20, 2002).

143. U.S. Pub. Interest Research Group v. Stolt Sea Farm, Inc., Civ. No. 00-149-B-C, 2002 U.S. Dist. LEXIS 12590 (D. Me. Feb. 20, 2002) (order affirming recommended decision; recommended decision by Mag. Kravchuk).

144. "USPIRG cases" refers to *Atlantic Salmon*, 215 F. Supp. 2d 239, *Heritage Salmon*, 2002 U.S. Dist. LEXIS 2706, and *Stolt Sea Farm*, 2002 U.S. Dist. LEXIS 12590.

145. *Atl. Salmon*, 215 F. Supp. 2d at 246 (quoting Nat'l Wildlife Fed'n v. Gorsuch, 693 F.2d 156, 165 (D.C. Cir. 1982)).

146. Importantly though, relying on a case involving a dam, *National Wildlife Federation v. Gorsuch*, 693 F.2d 156, 174–75 (D.C. Cir. 1982), and another case addressing a pumped storage facility (National Wildlife Federation v. Consumers Power Co., 862 F.2d 580, 584 (6th Cir. 1988) (stating that for there to be an "addition," a source must "physically introduce[ ] a pollutant into water from the outside world)), the court held that because the pollutants at issue were "put in the water by ASM as part of its operation," and they "do not naturally occur in the bay," they are "additions." *Atl. Salmon*, 215 F. Supp. 2d at 248–49; *see also* Catskill Mountains Chapter of Trout Unlimited v. City of New York, 273 F.3d 481, 491 (2d Cir. 2001); Ass'n of Pac. Fisheries v. EPA, 615 F.2d 794, 806–07 n.7, 815–16 (9th Cir. 1980) (fish wastes discharged by seafood processors are pollutants). *Cf.* Lisa A. Brautigam, *Control of Aquatic Nuisance Species Introductions Via Ballast Water in the United States: Is the Exemption of Ballast Water Discharges from Clean Water Act Regulation a Valid Exercise of Authority by the Environmental Protection Agency?*, 6 OCEAN & COASTAL L.J. 33 (2001); Sandra B. Zellmer, *The Virtues Of "Command and Control" Regulation: Barring Exotic Species From Aquatic Ecosystems*, 2000 U. ILL. L. REV. 1233, 1285 (2000). The court also found the mariculture operations were "point sources" in that net pens were "concentrated aquatic animal production facilities" (CAAPFs) within the meaning of EPA's regulations. EPA Administered Permit Programs: The National Pollutant Discharge Elimination System, 40 C.F.R. § 122 app. C (2003); *see also id.* § 122.24. More specifically, the court found that the net pens were "ponds, raceways or other similar structures" and, irrespective of the fact that the net pens did not discharge pollutants from a "discrete discharge pipe," they released pollutants into the bay from an "identifiable, discernible, confined, and discrete emission or conveyance," and hence were point sources. *Atl. Salmon*, 215 F. Supp. 2d at 255; *see also* 33 U.S.C. § 1362(14) (2000) (defining "point

as "dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, *biological materials*, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water".[147] In *USPIRG v. Atlantic Salmon of Maine, LLC*, the court found that various materials added by the mariculture operations were "pollutants" within the meaning of the CWA.[148] Specifically, the court held[149] that: (1) salmon feces and urine "constitute 'biological materials' or 'agricultural wastes,'" (2) the uneaten pigments, canthaxanthin, and astaxanthin, and the antibiotic, oxytetracycline which "flow out of ASM's pens" or "falls through the net pens . . . are subsumed in the category of 'chemical wastes,'" (3) cypermethrin, which is used to kill sea lice, and the chemicals Finquel and Parasite-S are "released into the water after their use," are included "within the category of 'chemical wastes,'" and (4) copper, which is a component of an antifoulant that is applied to the nets to reduce marine growth, is specifically listed by the EPA as a toxic pollutant in 40 C.F.R. § 401.15(22).[150]

source" as any "discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.").

147. 33 U.S.C. § 1362(6) (emphasis added). Several types of material are explicitly excluded from the definition: sewage from a vessel, discharges incidental to normal operation of an Armed Forces vessel, and certain discharges of materials associated with oil and gas production. *Id.*

148. *Atl. Salmon*, 215 F. Supp. 2d at 239.

149. The court made similar findings, with slightly different pollutant constituents in the other two companion cases. U.S. Pub. Interest Research Group v. Heritage Salmon, Civ. No. 00-150-B-S, 2002 U.S. Dist. LEXIS 2706, at *20–30 (D. Me. Feb. 20, 2002); U.S. Pub. Interest Research Group v. Stolt Sea Farm, Inc., Civ. No. 00-149-B-C, 2002 U.S. Dist. LEXIS 12590, at *16–24 (D. Me. Feb. 20, 2002).

150. *Atl. Salmon*, 215 F. Supp. 2d at 243–48. The court did not consider whether farmed Atlantic salmon could be viewed as pollutants because they serve as a vehicle for polychlorinated biphenyls (PCBs) and other contaminants. A recent study found that farmed salmon in British Columbia have "consistently higher levels" of total PCBs (51,216 vs. 5,302 pg/g), polybrominated diphenylethers (PBDEs) (2,688 vs. 178 pg/g), and organopesticides (other than toxaphene) (41,796 vs. 12,164 pg/g) than wild salmon. Michael D.L. Easton et al., *Preliminary Examination of Contaminant Loadings in Farmed Salmon, Wild Salmon and Commercial Salmon Feed*, 46 CHEMOSPHERE 1053 (2002). It should be noted, however, that these are preliminary findings based on a small sample size that did not allow the authors to conduct tests to determine whether the differences are statistically significant. *Id.* at 1062. *See also* Miriam Jacobs et al., *Investigation of Polychlorinated Dibenzon-p-dioxins, Dibenzo-p-furans and Selected Coplanar Biphenyls in Scottish Farmed Atlantic Salmon* (Salmo salar), 47 CHEMOSPHERE 183, 191 (2002) (finding high concentrations of PCBs and other contaminants in a sample of 10 farmed-raised salmon). Much of the origin of the higher contaminant levels is apparently contaminated salmon feed (which itself would be a pollutant). *Id.*; Easton et al., *supra* this note, at 1071–72. According to Toxic Pollutant Effluent Standards, 40 C.F.R. § 129.105 (2003), which establishes EPA effluent guidelines for PCB discharge and which

Most importantly for present purposes, the *Atlantic Salmon* court also addressed the question of fish as pollutants. First, the court noted that "some" of the salmon grown in ASM's net pens is of "non-North American origin."[151] The court also found that farm-raised salmon can be differentiated from wild salmon because they have "shortened and eroded fins, a plumper body, and a smaller head-to-body ratio . . . ."[152] Next, the court noted that it was undisputed that some cultured salmon escape from the net pens.[153] Finally, relying on *National Wildlife Federation (NWF) v. Consumers Power Co.*,[154] the court held that fish that "do not naturally occur in the water, such as non-North American salmon," fall within the term "biological materials" and are therefore pollutants under the Act.[155]

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applies to such heavy industrial users of PCBs as the PCB manufacturers themselves, electrical capacity manufacturers, and electrical transformer manufacturers, PCBs are prohibited in any discharge from any existing or new source. The regulations also state that the ambient water criterion for PCBs is 0.001 μ g/l. *Id.* If instead of being reared in mariculture facilities, contaminated farmed salmon were sent down an outflow pipe at a PCB manufacturing facility, they could constitute an illegal discharge of PCBs. We thus might ask the question: are Atlantic salmon reared in net pens pollution in the conventional sense?

151. *Atl. Salmon*, 215 F. Supp. 2d 239, 244, 247 (D. Me. Feb. 20, 2002) (although it primarily raised native salmon, approximately 100,000 of the salmon were not native to North America; some farm-raised salmon is non-North American in origin).

152. *See Stolt Sea Farm*, 2002 U.S. Dist. LEXIS 12590, at *7; *Heritage Salmon*, 2002 U.S. Dist. LEXIS 2706, at *10 (stating that farm-raised salmon "can be differentiated from wild salmon by the bluntness of their fins, a deformity caused by stresses associated with crowded pens" as well as the fact that some farm-raised salmon have deformities due to physical injuries or unbalanced nutrition).

153. *Atl. Salmon*, 215 F. Supp. 2d at 247. "In December 2000, approximately 100,000 [non-native] fish escaped from ASM's Stone Island Farm during a storm." *Id.* at 244; *see also Heritage Salmon*, 2002 U.S. Dist. LEXIS 2706, at *6 ("In November 2000, approximately 13,100 fish escaped . . . when a boat tore a hole in a net . . . . In 1994 and 1998, Heritage lost a total of 90,359 fish . . . .").

154. 862 F.2d 580, 583 (6th Cir. 1988) (stating that "live fish, dead fish and fish remains . . . are pollutants within the meaning of the CWA, since they are biological materials"). In *Consumers Power*, however, the Sixth Circuit held that a permit was not required because the fish, which originated in Lake Michigan adjacent to the pumped storage facility, were released back into the lake, and thus, were not "added" within the meaning of CWA. *Id.* That part of the *Consumers Power* holding is not controlling in the salmon mariculture situation because with salmon mariculture, the fish—and in particular the non-native fish—did not originate in the vicinity of the net pens.

155. It is not entirely clear what the court meant by the phrase "do not naturally occur in the water." *Atl. Salmon*, 215 F. Supp. 2d at 247. First, does this mean that something must not be present in any water body to be a CWA "pollutant"? The answer to this is apparently "no" since the court relies on the example of "non-North American salmon," which, if we take Norwegian Atlantic Salmon as an example, are present in water in their natural environment off the coast of Norway. Thus, the court's use of the word "water" seems to connote a local portion of a much larger body of water (e.g., the Atlantic Ocean or a large river system) or a small water body such as a lake or creek.

Although the concern with possible genetic pollution of wild stock from mariculture escapees was well-articulated in a number of fora before the USPIRG cases,[156] the judge in the USPIRG cases did not mention possible genetic pollution of native stocks by escapees from mariculture operations. Nor did the court rely on the endangered status of wild Atlantic salmon stocks. Rather, the court focused solely on the fact that the escapees were of different origin[157] than the wild stock and were distinguishable from wild stock by external markers, both of which served to establish escapees as *introduced* to the navigable waters.[158] This dependence on differentiation from native stock as the sole criterion for the determination of the status of Atlantic salmon mariculture escapees as pollutants would not seem to preclude interpreting escapees from other types of aquaculture operations as pollutants under the CWA, provided the facilities in question met discharge and other criteria in order to be regulated under the CWA. Presumably, such a criterion would label transgenic salmon and other transgenic mariculture specimens as pollutants as well.

Since the court's orders affirming the recommended decisions in the *Atlantic Salmon* and *Stolt* cases were issued, there have been two

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Second, can a fish be a "pollutant," yet still be native to an area? In other words, if, for example, a native fish were to be released to a local environment in such great numbers that it impacted negatively on the ecology and ecological balance of that ecosystem, would the release still be "natural"? The answer to this second question is not so apparent. But we might begin by thinking about the addition of other "naturally" occurring materials to a water body. Nitrogen is "naturally" found in estuaries and indeed helps to create healthy aquatic ecosystems. Yet, it is well-known that the anthropogenic addition of nutrients such as nitrogen can lead to hypoxia and other deleterious conditions. Thus, it may be appropriate to consider "unnatural" any addition of a material or organism (e.g., fish) that raises the number, concentration or density above the background level of that material or organism in a water body, without regard to its native or non-native status, or alternatively, to peg it to a higher level—that is, the level when its number, concentration or density begins to have eco-systemic effects. *See Consumers Powers*, 862 F.2d at 583 (citing with approval the lower court opinion that held that fish can be pollutants even though they are a "natural constituent of the Lake." Nat'l Wildlife Fed'n v. Consumers Powers Co., 657 F. Supp. 989, 1006–07 (W.D. Mich. 1987)); *Atl. Salmon*, 215 F. Supp. 2d at 247; *see also Heritage Salmon*, 2002 U.S. Dist. LEXIS 2706, at *23; *see Stolt Sea Farm*, 2002 U.S. Dist. LEXIS 12590, at *12. This finding also is consistent with the EPA's understanding of the judicial interpretation of the term "biological materials." USEPA, *supra* note 133, at 32 (stating that courts have considered "different biological organisms, such as bacteria (e.g., fecal coliform), algae, dead fish, live fish, fish remains, and plants materials" to be "biological materials").

156. GENETIC STATUS OF ATLANTIC SALMON, *supra* note 7; Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 65 Fed. Reg. at 69,471, 69,477–78.

157. *Heritage Salmon*, 2002 U.S. Dist. LEXIS 2706, ¶¶ 17–18, 22–23 (D. Me. Feb. 20, 2002) (consent decree and order).

158. *Atl. Salmon*, 215 F. Supp. 2d at 247–48.

significant developments in the USPIRG cases. First, on July 29, 2002, the court approved a detailed settlement entered into by USPIRG and Heritage to settle USPIRG's claims against Heritage.[159] In pertinent part, the settlement requires Heritage, prior to receiving any applicable permits from the United States or the State of Maine, to: (1) forgo the use of non-North American stocks and transgenic salmonids; (2) limit the stocking densities in its net pens; (3) fallow its salmon farms; and (4) take precautions and institute measures so that cultured fish do not escape.[160]

Although the settlement with Heritage is far-reaching, it curiously fails to include three components. First, the settlement allows Heritage to continue to use Canadian stocks. This is significant given that the court ruled that non-native stocks are pollutants and, as discussed below, the National Academy of Science panel recently concluded that the evidence is "surprisingly strong" that Maine and Canadian stocks are genetically distinct. Second, although the settlement requires Heritage to obtain an NPDES permit from Maine for any *new* lease site, it merely requires compliance with any similar permit that may be issued for its existing sites; there is no requirement that Heritage apply for such permits for its existing sites or cease operations at some defined date at those sites if it is unable to secure the necessary permits.

Third, while the court will retain jurisdiction under 33 U.S.C. § 1365 to enforce Heritage's commitments, the settlement does not require Heritage to pay stipulated penalties or liquidated damages in the event of a breach of its obligations.[161] This is significant given that CWA statutory penalties do not attach to violations of the court's decree.[162] In contrast, if Heritage possessed an NPDES permit, Heritage would be strictly liable for administrative and civil judicial fines of up to $25,000 per day for violations of the terms of the permit, and additionally, criminal felony penalties would attach for knowing violations.[163] Without the more immediate effect of stipulated penalties, Heritage has

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159. The settlement was lodged on June 4, 2002, two weeks prior to the court's orders affirming the recommended decisions in *Atlantic Salmon* and *Stolt Sea Farm*. To date, no proposed settlements have been reached in the other two USPIRG cases.

160. *Heritage Salmon*, 2002 U.S. Dist. LEXIS 2706, ¶¶ 17–18, 22–23. The settlement requires Heritage to undertake measures to ensure water quality and prevent benthic impacts, *id.* ¶¶ 31–53, as well as to pay a total of $750,000 to fund wild Atlantic salmon restoration efforts and to reimburse the plaintiffs for the cost of litigation, including attorney's fees. *Id.* ¶¶ 54, 57.

161. *Heritage Salmon*, 2002 U.S. Dist. LEXIS 2706, ¶ 56.

162. 33 U.S.C. § 1391(c)–(d) (2000).

163. *Id.*

much less incentive to comply with terms it has agreed to such as forgoing the use of European stocks of Atlantic salmon. This is particularly so given that, as noted earlier, Heritage is not required to obtain permits for its existing net-pen farms.

Second, on February 13, 2003, the Judge entered an interlocutory order preventing Atlantic Salmon of Maine, LLC from introducing a "new class of fish" into its pens until the completion of the remedial phase of the case.[164] Despite that order, Atlantic Salmon of Maine, LLC had 100,000 Atlantic salmon hatchery smolt stocked into net pens in April, 2003 and indicated its intention to stock more than 500,000 additional smolt.[165] On May 9, 2003, the court held Atlantic Salmon of Maine, LLC in contempt.[166]

C. *State and Federal Cases Arising out of Washington*

Interestingly, the USPIRG cases do not present the first occasion in which a court considered whether or not farm-raised Atlantic salmon constitute pollutants.[167] In Washington, the State had been delegated authority to administer the NPDES permit system within its boundaries using state law. Accordingly, when a case involving the issue arose in a Washington state court, *Marine Environmental Consortium v. Washington Department of Ecology*,[168] the court applied Washington law to the question of regulation rather than federal law.[169] Moreover, rather than being the result of a citizen suit trying to enforce discharge requirements against an entity that had no permit, the Washington case arose as an appeal brought by nonprofit environmental and fishing organizations. The organizations challenged two things: (1) a permit issued by an administrative agency, the Washington Department of

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164. USPIRG v. Atl. Salmon of Me. (II), (D. Me. Feb. 13, 2003), *available at* http://www/med/uscourts.gov/Site/opinions/carter/2003/GC_02132003_1-00cv151_PIRG_v_Atlantic_Salm.pdf.

165. USPIRG v. Atl. Salmon of Me. (III), 2003 U.S. Dist. LEXIS 8002 at *13 (D. Me. May 9, 2003).

166. *Id.* The court ordered the company to remove the smolt and to fallow the net pens no later than May 28, 2003 or pay a $10,000 fine for each day the net pens are not completely fallowed after that date and pay a fine of $100,000 per day for any further stocking. *Id.* at *43–44. The court subsequently denied the company's motion for a stay of the civil contempt order. USPIRG v. Atl. Salmon of Me. (IV), 2003 U.S. Dist. LEXIS 8612 (D. Me. May 19, 2003).

167. *See, e.g.*, Marine Envtl. Consortium v. Wash. Dep't of Ecology, No. 99-2-00797-0, slip op. ¶ II.VII. (Wash. Super. Ct. Dec. 1, 2000).

168. *Id.*

169. *Compare Marine Envtl. Consortium*, ¶ II.I., II.VIII., II.IX *with Heritage Salmon, Atl. Salmon, and Stolt Sea Farm.*

Ecology (WDE), and (2) a decision by a quasi-judicial body, the Washington State Pollution Control Hearings Board (WPCHB).[170]

The main issue before the WPCHB was the risk posed to native Pacific salmon by farm-raised Atlantic salmon, which were not native to the Pacific Northwest—in particular, the risk that escapees might "colonize Puget Sound rivers."[171] The WPCHB had before it evidence of two escape incidents—105,000 and 369,000 escapees, in July 1996 and July 1997, respectively—as well as evidence of the presence of at least twelve Atlantic salmon smolts in the Tsitika River.[172] In the face of "substantial conflict in the testimony of expert, agency and lay witnesses," the WPCHB found *inter alia* that "while undesirable," the accidental release of Atlantic salmon did "not pose a significant threat to native salmon" nor "degrade water quality."[173] However, the WPCHB also found substantial evidence in the record to support a finding that "regular and large releases such as those that occurred in 1996 and 1997 could constitute a threat to Pacific salmon."[174] On the issue of spawning, the WPCHB concluded that while there "may have been successful spawning" of escapees, there was "no evidence to support that Atlantic salmon was 'self-sustaining.'"[175] Here, the WPCHB took a middle ground, ordering the WDE to "take the Tsitika findings fully into account when it considers and reissues" the permits.[176]

As an initial matter, the court found that the release of farmed Atlantic salmon from net pen facilities is regulated under the NPDES permit program.[177] At the same time, the court, deferring to the administrative interpretation and application of the law by the WPCHB,[178] held that the inadvertent release of Atlantic salmon is neither "pollution" within the meaning of Washington law[179] nor, at a current level of escapement, a "nuisance." In addition, the court held that the inadvertent release does not "render [State] waters harmful, detrimental or injurious to salmonid species" or violate water quality

170. *Marine Envtl. Consortium*, ¶ I.I.
171. *Id.* ¶ I.III, I.VI.
172. *Id.* ¶ I.IV, I.XII.
173. *Id.* ¶ I.VIII–IX.
174. *Id.* ¶ I.IX.
175. *Id.* ¶ I.XIII.
176. *Id.*
177. *Id.* ¶ II.VII.
178. *Id.* ¶ II.IV–V.
179. This leads to the anomalous result that the federal standard of "pollution" is more stringent than the Washington standard since any escape of non-Native farm-raised salmon would constitute the release of a "pollutant" under the CWA. *See infra* note 332 and accompanying text.

standards.[180] The court also affirmed the WPCHB's findings with regard to the Tsitka River and its decision to require the WDE to modify the permits accordingly.[181]

Another case arising out of the State of Washington, a Ninth Circuit opinion, addresses the CWA regulation of mussel-harvesting facilities and bears on the question of whether or not salmon mariculture escapees are pollutants, as well as the broader issue of fish as pollutants.[182] In *Ass'n to Protect Hammersley, Eld, & Totten Inlets v. Taylor Resources, Inc.* (APHETI), the defendant-appellee, Taylor Resources, Inc. (Taylor) operated two mussel-harvesting facilities in Puget Sound's Totten Inlet and produced more than 20,000 pounds of mussels annually. Taylor harvested a species of mussels known as Gallo that had been present in the Puget Sound for approximately twenty-five years and that "reproduce naturally in Puget Sound, albeit in limited numbers."[183] There was some dispute over whether Gallo mussels were introduced into Puget Sound solely as the result of the actions of mussel harvesters, or whether, in addition, they independently found their way to the Sound.[184] A mesh net surrounded the farm-raised mussels.[185] However, unlike Atlantic salmon farming operations that add fish food and other chemicals to the water, the Gallo mussels are "nurtured exclusively by the nutrients found naturally in the waters of Puget Sound, *with nothing added*."[186] Nevertheless, as a byproduct of their metabolism, the mussels "produce and release" particulates, feces and psuedo-feces and generate ammonium and inorganic phosphate; mussel shells are released from the nets as well.[187]

When Taylor applied for an NPDES permit, the WDE informed Taylor it would "neither accept nor process" the application.[188] According to the WDE, the mussel facilities did not require discharge permits because fish food (nutrients) is not used to promote shellfish

180. Marine Envtl. Consortium v. Wash. Dep't of Ecology, No. 99-2-00797-0, slip op. ¶ II.VIII, II.X (Wash. Super. Ct. Dec. 1, 2000). For further discussion of this case see *infra* note 282.

181. Marine Envtl. Consortium v. Wash. Dep't of Ecology, No. 99-2-00797-0, slip op. ¶ II.XIII.

182. Ass'n to Protect Hammersley, Eld, &Totten Inlets v. Taylor Res., Inc., 299 F.3d 1007, 1009 (9th Cir. 2002) [hereinafter *APHETI*].

183. *Id.* at 1010 n.1.

184. *Id.* This latter point was put forward by amicus curiae Pacific Coast Shellfish Growers Association. *Id.*

185. *Id.* at 1010.

186. *Id.* (emphasis added).

187. *Id.*

188. *Id.* at 1011.

growth.[189] Subsequently, APHETI filed a citizen suit under the CWA alleging that Taylor was violating the Act by discharging mussel feces, mussels shells and ammonia into Puget Sound without a permit.[190]

Two policy considerations complicated the legal question of whether the mussel operations resulted in the "discharge of a pollutant" from a "point source."[191] First, mussels filter excess nutrients that otherwise can harm marine ecosystems, thus enhancing water quality.[192] Second, regulation of these types of operations could divert regulators' finite financial and personnel resources away from other more environmentally-significant activities such as pollution prevention.[193]

Taking the issue of whether these facilities constitute point sources first, the court deferred to the EPA's determination of which mariculture facilities should be considered point sources under the CWA. The court concluded that the mussel operations were not "point sources" within the meaning of the Act because the EPA had excluded facilities that feed less than approximately 5,000 pounds of food per month in a given calendar year.[194] The implication for Atlantic salmon mariculture operations of this portion of the Ninth Circuit opinion is that those operations that exceed the feeding and production criteria set forth in EPA regulations are "point sources" within the meaning of the CWA.[195]

The more difficult substantive issue the *APHETI* court faced was what constitutes "biological materials" for the purposes of the CWA. The Ninth Circuit noted the term "biological materials" was ambiguous because it was unclear whether it included all "biological matter regardless of quantum and nature and regardless of whether generated by living creatures, or whether the term is limited to biological materials

189. *Id.* at 1009.

190. *Id.*

191. *Id.* at 1010–11. Although the United States filed an amicus brief in this matter, it took no position on the issue of "biological materials" as "pollutants." Personal communication with David Mann, counsel for APHETI (Oct. 1, 2002).

192. Ass'n to Protect Hammersley, Eld, &Totten Inlets v. Taylor Res., Inc., 299 F.3d 1007, 1010 n.2 (9th Cir. 2002). This argument was advanced by several Native American tribes that participated as amici curiae. *Id.*

193. *Id.* at 1011 n.3. These concerns were raised by amici Jamestown S'Klallam Tribe and People for Puget Sound. *Id.*

194. *Id.* at 1018–19 (noting that the mussel operations were not entitled to the other regulatory exclusion—minimum production levels). The *APHETI* court also might have been influenced by the fact that the statutory definition of point source includes a "concentrated animal *feeding* operation." 33 U.S.C. § 1362(14) (2000) (emphasis added).

195. *See* EPA Administered Permit Programs: The National Pollutant Discharge Elimination System, 40 C.F.R. § 122 app. C (2003).

that are a waste product of some human [or industrial] process."[196] In resolving the ambiguity in favor of the latter interpretation, the court advanced five reasons. First, the court observed that under the doctrine of *ejusdem generis*,[197] the more specific illustrative lists of pollutants—"radioactive materials," "wrecked or discarded equipment," "garbage," "sewage sludge," "solid waste," and "incinerator residue," set forth in 33 U.S.C. § 1362(6), suggest that the more general term "biological materials" refers to a "waste material of a human or industrial process."[198] Second, when it enacted the CWA, Congress specifically listed the "propagation" of "shellfish" as a goal.[199] Third, there was no evidence in the record that the release of mussel shells, mussel feces, or other byproducts results in any harm.[200] Fourth, viewing biological materials as requiring transformation by a human or industrial process was in accord with other courts that had considered the question.[201] Finally, the CWA defines a closely related term, "pollution," to mean "*man-made or man-induced* alteration of the chemical, physical, biological, and radiological integrity of water."[202] In sum, the Ninth Circuit held that mussel shells, mussel feces, and other byproducts, although released into the environment, "come from the natural growth and development of mussels" rather than from the "waste product of a transformative human process," and, as such, are not regulated under the

196. *APHETI*, 299 F.3d at 1016.

197. "[W]hen a statute contains a list of specific items and a general item, we usually deem the general item to be of the same category or class as the more specifically enumerated items." *Id.* (quoting Sutton v. Providence St. Joseph Med. Ctr., 192 F.3d 826, 834 (9th Cir. 1999)) (internal citations omitted).

198. *Id.* We question why the court felt it necessary to rely on this rule of statutory construction given the breadth of so-called "specific" terms such as "garbage," "sewage sludge," and "solid waste" and the fact that it had other bases for its holding.

199. *Id.* (quoting 33 U.S.C. § 1251(a)(2)); *see also* 33 U.S.C. §§ 1312(a), 1314(a)(2).

200. *APHETI*, 299 F.3d at 1016.

201. *Id.* at 1017 (citing Concerned Area Residents for Env't. v. Southview Farm, 34 F.3d 114, 117 (2d Cir. 1994) (liquid manure that had been spread on farm fields); United States v. Plaza Health Labs., Inc., 3 F.3d 643, 645 (2d Cir. 1993) (holding that glass vials containing human blood that were placed into a river were biological materials); Nat'l Wildlife Fed'n v. Consumers Power Co., 862 F.2d 580, 583 (6th Cir. 1988) (holding that "live fish, dead fish and fish remains" released through a dam's turbines were biological materials); United States v. Frezzo Bros., 461 F. Supp. 266, 269–70 (E.D. Pa. 1978), *aff'd*, 602 F.2d 1123 (3d Cir. 1979) (holding that "mushroom compost" pile runoff was a biological material). Although those courts found that each of the above materials are "biological materials," the judicial opinions in those matters neither examined the meaning of "biological materials" in depth nor limited that term's meaning in the manner suggested by the *APHETI* court.

202. *APHETI*, 299 F.3d at 1017 (quoting 33 U.S.C. § 1362(19)).

CWA.[203]

Nonetheless, the *APHETI* court was careful to note that it was not suggesting that materials found naturally in the water can never be "biological materials" within the meaning of the CWA.[204] As an example, the court indicated that discarded fish parts and shells, "although naturally occurring, are altered by a human or industrial process, and as waste materials in significant amounts, might affect the biological composition of the water."[205] More importantly, by citing the critical holding in *NWF v. Consumers Power Co.*[206] with approval, the Ninth Circuit also implied that, although its view of what constituted "biological materials" under the CWA was narrower than that advocated by the plaintiffs, even a more limited interpretation of biological materials would include the discharge of "live fish, dead fish and fish remains" through a dam turbine.[207] Thus, under the *APHETI* reasoning, to the extent that farm-raised Atlantic salmon escape as a result of a transforming human process, they would be considered to be "biological materials" and hence "pollutants" within the meaning of the CWA.[208]

The Washington cases are important not only because they raise the issue of escaped farmed fish as pollutants, but also because in conjunction with the recent Maine cases, they illustrate the need for a coherent and cohesive national policy regulating the intentional and unintentional release of farmed aquatic life into the nation's waters. Without such a policy, courts will continue to arrive at potentially conflicting interpretations of the law in cases such as the Washington mussel case and the Washington and Maine salmon mariculture cases.

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203. *Id.* at 1017–19. The Ninth Circuit is not entirely persuasive on the distinction it is attempting to draw. For example, we question in what sense these releases were not "human-induced" given that, but for the placement of the mussels by humans in the Sound, their feces and shells would not have been released.

204. *Id.* at 1016–17.

205. *Id.* at 1017 (citing Ass'n of Pac. Fisheries v. Envtl... Prot. Agency, 615 F.2d 794, 802 (9th Cir. 1980)). It should be noted that such a finding may run head long into the *Consumers Power* case discussed earlier that found that, while live fish and fish parts were "pollutants" within the meaning of the CWA, no "addition" occurs when they are released back into the water. *See NWF v. Consumers Power Co.*, 862 F.2d 580, 584 (6th Cir. 1988).

206. 862 F.2d 580 (6th Cir. 1988); *see also supra* note 154 and accompanying text.

207. *APHETI*, 299 F.3d at 1017 (quoting *Consumers Power*, 862 F.2d at 583) (dealing with a pump storage facility rather than a dam).

208. *See id.* As previously noted, the court in the *USPIRG* cases did not rely on the endangered species status of wild Atlantic salmon as a justification. Rather, the court rested its decision on the literal meaning of "biological materials," one of the items Congress defined as a "pollutant" under the CWA, and the fact that the stocks in question were not native to the Gulf of Maine. *See supra* notes 151–54.

D. *Proposed EPA Action to Regulate Escapes: A Step Forward or Backward?*

Recently, the EPA has taken a cautious step toward distinguishing which farmed fish should be regulated as pollutants and which ones should not. Specifically, in proposed aquaculture effluent guidelines, the EPA states that persons operating certain net pen systems must "develop and implement [best management] practices ["BMPs"] to minimize the potential [unintended] escape of non-native species."[209] These practices—such as installing double netting in a net pen operation[210]—would be embodied in a non-native species escapement plan.[211]

The EPA's proposal is important in several respects. First, given the EPA's intention to regulate the escape of net-pen farm-raised fish, the EPA has implicitly determined that their escape constitutes the "discharge" of a "pollutant" from a point source.[212] Second, in the proposed rule, the EPA defines a non-native aquatic animal species as an "individual, group or population of a species . . . [t]hat is introduced into an area or ecosystem outside its historic or native geographic range" and that "has been determined and identified by the appropriate State or Federal authority to threaten native aquatic biota."[213] While this definition rightly recognizes that non-nativeness should be examined at the subspecies level, it may have limited applicability given that it only applies in those instances where a state or federal entity has made a formal determination that the non-native strain constitutes a threat. It would nonetheless appear to encompass the rearing of non-native strains of Atlantic salmon off the coast of Maine. Third, as discussed next, the EPA's proposed rule is limited in a number of respects, some of which

209. Effluent Limitation Guidelines, 67 Fed. Reg. 57,872, 57,928 (proposed Sept. 12, 2002) (to be codified at 40 C.F.R. pt. 451). Also, the EPA has recently developed a draft guidance manual that sets forth best management practices and attempts to assist aquaculturalists in meeting the proposed effluent guidelines. EPA, *Draft Guidance for Aquatic Animal Production Facilities to Assist in Reducing the Discharge of Pollutants*, EPA-821-B-02-002, *available at* http://epa.gov/guide/aquaculture/guidance/complete.pdf (Aug. 2002) [hereinafter EPA'S DRAFT GUIDANCE].

210. Effluent Limitation Guidelines, 67 Fed. Reg. at 57,887.

211. *Id.*

212. *See* EPA'S DRAFT GUIDANCE, *supra* note 209, at 4–16. In light of the *APHETI* court's finding that the term "biological materials" is ambiguous, under *Chevron United States of America v. Natural Research Defense Council*, 467 U.S. 837, 866 (1984), a court would defer to any reasonable interpretation of that term by the EPA. For an analysis of the deference actually given to the EPA by the judicial branch, see Christopher H. Schroeder & Robert L. Glicksman, *Chevron, State Farm, and EPA in the Courts of Appeals During the 1990s*, 31 ENVTL. L. REP. 10371 (2001).

213. Effluent Limitation Guidelines, 67 Fed. Reg. at 57,925.

significantly undercut the otherwise far-reaching holding of the USPIRG cases.

To begin with, the proposed effluent guidelines explicitly exempt "species raised for stocking by public agencies" from the definition of "non-native aquatic animal species."[214] As discussed in more detail below, while a large number of federal and state fish hatcheries raise non-native species and have NPDES permits, those permits do not authorize the intentional[215] or unintentional release of fish.[216] This proposal would appear to authorize such releases without regard to the biological consequences. Second, the EPA's proposal is limited to the escape of non-native fish rather than any farmed fish. As noted elsewhere in this article, there are likely to be subtle genetic distinctions between wild and captive-bred populations.[217] Third, although the EPA regulates concentrated aquatic animal production facilities (CAAPFs) that produce as little as 20,000 pounds annually of any cold water species, the proposed effluent limitations do not apply to facilities that produce less than 100,000 pounds annually. The EPA established the 100,000-pound threshold based on economic modeling that led it to conclude that the proposed limitations would have adverse economic effects on trout producers that produce less than 94,000[218] pounds annually.[219]

Fourth, the guidelines do not take into account the potential biological impact of an escape. For example, the stringency of the requirements is not based on whether populations potentially affected are endangered or threatened.[220] Fifth, the proposed guidelines are

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214. *Id.*

215. Intentional releases include stocking for sport fishing.

216. *See, e.g.*, Telephone Interview with Gary Whelan, Fish Production Manager, Michigan Department of Natural Resources (MDNR) (Apr. 15, 2002) (while MDNR managed hatcheries have discharged permits, they do not have permits authorizing releases for stocking purposes).

217. While the court confined the opinions in the *USPIRG* cases to escape of non-native stock, EPA's proposed effluent guidelines appear to rule out treating native cultured stocks as "pollutants." *See, e.g.*, U.S. Pub. Interest Research Group v. Atl. Salmon of Me., LLC, 215 F. Supp. 2d 239, 247–49 (D. Me. 2002); Effluent Limitation Guidelines, 67 Fed. Reg. at 57,925.

218. The EPA does not explain why it chose 100,000 rather than 94,000 pounds as the cutoff. *See* Effluent Limitation Guidelines, 67 Fed. Reg. at 57,925.

219. *See id.* The EPA found that "small facilities would experience compliance costs that exceed 5% of their revenues which is higher than for large facilities." *See id.* Moreover, a facility that produces between 20,000 and 100,000 pounds annually would not be exempted from the NPDES permit requirement. Rather, it would be subject to conditions in an NPDES permit based on the "best professional judgment" of the permit writer. *See id.*

220. *Id.* at 57,928.

directed at minimizing rather than preventing escapes.[221] Moreover, they do not even require that escapes actually be minimized. Rather, they only establish the principle that operators should implement best management practices to minimize escapes.[222] In other words, rather than an escape leading to a strict liability permit violation, any CWA liability for escapes under the proposed guidelines is premised solely on the failure of a facility operator to use best management practices. Finally, the EPA underscored its ambivalence to address this "potential area of concern"[223] with its statement that it was "considering whether it should establish national requirements for net pens systems at all."[224] In sum, given the limitations in the EPA's proposed effluent guidelines as outlined here, the EPA's proposal would appear to cut the legs out from under the Maine district court's rulings on escapees.[225]

Although the EPA did not specifically propose any rule related to the intentional release of farmed fish—for example, in the event that net penned farmed fish are not "growing rapidly enough to justify continued feeding"—the EPA indicated that it was considering banning such practices.[226] This statement highlights another peculiarity of the proposed rule. It is not clear how the EPA can reconcile a requirement that facility operators minimize escapes while otherwise providing those same facility operators with carte blanche to intentionally release farmed fish.

From the standpoint of the Atlantic salmon mariculture industry, the money saved in building "leaky" Atlantic salmon net pens from which a considerable number of fish can escape is more than the money represented by lost fish.[227] Nevertheless, if the EPA adopts as a final rule even the rather limited regulatory framework proposed and mandates that Atlantic salmon operators use best management practices to minimize escapes as part of any Atlantic salmon mariculture NPDES permit, then the industry will either have to comply with that directive or go out of business.

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221. *Id.*

222. *Id.*

223. *Id.* at 57,912.

224. *Id.* at 57,901.

225. *See, e.g.*, U.S. Pub. Interest Research Group v. Atl. Salmon of Me., LLC, 215 F. Supp. 2d 239, 247–48 (D. Me. 2002).

226. *Id.* An intentional release of farmed fish would appear to fit easily within the *APHETI* court's standard of a waste product generated by a human-induced process. *APHETI*, 299 F.3d at 1017–18.

227. Volpe, *supra* note 105, at 14.

E. *A Draft Code of Conduct*

Finally, the National Maritime Fisheries Service ("NMFS") has recently taken steps to establish guidelines for aquaculture with the publication of a draft code of conduct for mariculture operations in federal waters, which may assist Atlantic salmon recovery efforts.[228] While potentially far-reaching in some respects, unlike the EPA effluent guidelines mentioned above, the proposed code of conduct is "soft" law—that is, if it is adopted, compliance will be voluntary.[229] In pertinent part, the code of conduct expresses many of the concerns voiced here and calls for the adoption of the "precautionary approach" combined with "adaptive management" to be the "guiding principles" while recognizing the imperative of preventing escapes, combined with the remedial action to address significant escape incidents.[230]

IV. LEGAL STATUS OF WILD ATLANTIC SALMON

In this section we trace the legal status of wild Atlantic salmon over the past several decades. Most of our focus is on the consideration of Atlantic salmon under the Endangered Species Act, which culminated in a recent decision by the federal government to list the Gulf of Maine Atlantic salmon D.P.S. as endangered. However, the controversy surrounding the legal status of wild Atlantic salmon did not end with that listing. Indeed, the controversy led Congress to ask the National Research Council (NRC) for scientific advice on "understanding and reversing the declines in Maine's salmon population," the issuance of an interim report by the NRC Committee on Atlantic Salmon in Maine on

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228. NAT'L MAR. FISHERIES SERV., A CODE OF CONDUCT FOR RESPONSIBLE AQUACULTURE DEVELOPMENT IN THE U.S. EXCLUSIVE ECONOMIC ZONE, *available at* http://www.nmfs.noaa.gov/trade/AQ/AQcode.pdf (2000) [hereinafter CODE OF CONDUCT]; *see also* EPA'S DRAFT GUIDANCE, *supra* note 209, § 4.10; ATL. STATES MARINE FISHERIES COMM'N, GUIDANCE RELATIVE TO DEVELOPMENT OF RESPONSIBLE AQUACULTURE ACTIVITIES IN ATLANTIC COAST STATES, No. 76 (2002); FOOD & AGRIC. ORG. OF THE UNITED NATIONS, CODE OF CONDUCT FOR RESPONSIBLE FISHERIES, ART. 9, *available at* http://www.fao.org/fi/agreem/codecond/ficonde.asp (1995).

229. *See* CODE OF CONDUCT, *supra* note 228, § 3.

230. *See id.* §§ 6.5.1, 6.6.3. The Code also calls for best management practices; conservation of genetic diversity and the maintenance of the functional integrity of ecosystems; regulation of non-indigenous aquatic organisms and genetically-altered species; adoption of necessary measures to minimize the potential for the incidence and transmission of diseases and parasites; and protection of critical habitats, protected areas, endangered species, etc. through siting criteria, monitoring, assessment, and enforcement. *Id.* §§ 6.3.2–3, 6.5.2–3, 6.5.4–5, 6.6.3.

the genetic makeup of Atlantic salmon populations in Maine,[231] and a legal challenge to the listing.[232]

A. Legal Framework

In 1976, Congress enacted the Fishery Conservation and Management Act[233] and, among other things, established eight regional fishery management councils that are each tasked to prepare and submit to the Secretary of Commerce a fishery management plan for fisheries within their respective regions.[234] The New England Fishery Management Council (NEFMC) has jurisdiction over fish in federal waters bordering Maine's and other New England states' coastal waters.[235] In 1988, the NEFMC adopted a Fishery Management Plan (FMP) for Atlantic salmon.[236] The FMP prohibits the possession of wild Atlantic salmon harvested in federal waters.[237] The Magnuson Act authority complemented existing federal regulatory authority over Atlantic salmon on the high seas—the area beyond nations' exclusive economic zone that was conferred to the United States by the Convention for the Conservation of Salmon in the North Atlantic Ocean[238] and the North Atlantic Salmon Conservation Organization[239]—as well as state authority.[240] A 1999 amendment to the Atlantic salmon FMP created an administrative process for persons desiring to operate an Atlantic salmon mariculture project in federal waters.[241]

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231. GENETIC STATUS OF ATLANTIC SALMON, *supra* note 7.

232. Maine v. Norton, 262 F.3d 13 (D. Me. 2000).

233. Pub. L. No. 94-265, 90 Stat. 436 (codified as amended at 16 U.S.C. §§ 1801–1883 (2000)). The Act has since been amended and is now known as the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA or Magnuson Act).

234. 16 U.S.C. § 1852(a)(1).

235. *Id.*

236. The plan was written in 1987, see Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,462 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 17), and implemented in 1988, see NEW ENGLAND FISHERY MGMT. COUNCIL, ATLANTIC SALMON FISHERY MANAGEMENT PLAN SUMMARY (1999), *available at* http://www.nefmc.org/.

237. Fisheries of the Northeastern United States, 50 C.F.R. § 648.40 (2003).

238. Convention for the Conservation of Salmon in the North Atlantic Ocean, *at* www.nasco.org.uk/pdf/nasco_convention.pdf (Oct. 1, 1983).

239. The North Atlantic Salmon Conservation Organization's website is at http://www.nasco.org.uk (Last visited July 27, 2003).

240. *See* 16 U.S.C. § 1856.

241. 50 C.F.R. § 648.41. There is some question whether, as a matter of law, the Magnuson Act actually confers on NOAA, NMFS and the regional Fisher Management Councils (FMCs) the power to regulate aquaculture. There is no explicit authorization in the Magnuson Act to regulate

The Endangered Species Act (ESA) sets forth a far-reaching regulatory regime that provides protection for any species threatened or endangered with extinction.[242] The ESA defines "species" as "any subspecies of fish or wildlife or plants, and any *distinct population segment* of any species of vertebrate fish or wildlife, which interbreeds when mature."[243] The ESA directs the federal government to determine whether any species has become endangered or threatened due to habitat destruction, over-utilization, disease or predation, inadequacy of other regulatory mechanisms, or other natural or manmade factors.[244] Because salmonids are anadromous and spend a portion of their life cycle in both freshwater and saltwater, both NMFS and FWS have a role in determining the status of Atlantic salmon under the ESA.[245] That determination must be rendered "solely on the basis of the best scientific and commercial data available . . . ."[246]

The listing of a species as threatened or endangered has a whole host of implications. To begin with, the Services are required to designate critical habitat for the species,[247] and develop and implement a recovery

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aquaculture and the legislative history of the Act is silent on that question. While the Magnuson Act defines fishing to include "catching, taking, or harvesting of fish," 16 U.S.C. § 1802(15), it does not define "harvesting." It does, however, define "United States harvested fish" as "fish caught, taken, or harvested by vessels of the United States within any fishery regulated under this chapter." *Id.* § 1802(42). Because "harvesting" connotes bringing in a crop, NOAA has asserted that it has jurisdiction over mariculture in those instances when a mariculture facility is in part comprised of a vessel. *See* Memorandum from Jay S. Johnson, Deputy General Counsel, NOAA, & Margaret F. Hayes, Assistant General Counsel for Fisheries, NOAA, to James W. Brennan, Acting General Counsel, NOAA, Regulation of Aquaculture in the EEZ (Feb. 1, 1993) (on file with authors). *But see* Letter from James W. Brennan, Acting General Counsel, NOAA, to Robert Blumber, Bureau of Oceans and International Environmental and Scientific Affairs, Department of State, American Norwegian Fish Farm, Inc. (Feb. 1, 1993) (taking exception to the position of the Department of Justice that NOAA's jurisdiction under the Magnuson Act is limited to "naturally occurring stocks") (on file with authors). The NOAA General Counsel's Memorandum could be read to assert jurisdiction in any instance when a maricultured specimen is removed from a facility and placed on a vessel.

242. 16 U.S.C. §§ 1531–1544. A species is "endangered" within the meaning of the ESA if it is "in danger of extinction throughout all or a significant portion of its range" and "threatened" if it is "likely to become an endangered species within the foreseeable future. . . ." *Id.* § 1532(6), (20).

243. *Id.* § 1532(16) (emphasis added).

244. *Id.* § 1533(a)(1).

245. *Id.* § 1533(a)(2).

246. *Id.* § 1533(b)(1)(A). *See, e.g.*, N. Spotted Owl v. Hodel, 716 F. Supp. 479, 483 (W.D. Wash. 1988) (finding arbitrary and capricious conclusory assertions of agency expertise where the Department of the Interior spurned unrebutted expert opinions without itself offering a credible alternative explanation).

247. 16 U.S.C. § 1533(a)(3). Upon designating a species as threatened or endangered, the Services are required to designate critical habitat. For species listed prior to 1978, such designation is discretionary. *Id.*; *see also* Fund for Animals v. Babbitt, 903 F. Supp. 96, 115 n.8 (D.D.C. 1995).

plan that provides for the "conservation and survival" of the species.[248] In addition, the ESA prohibits the taking[249] of any endangered fish or wildlife species in most circumstances. In contrast, takings of threatened species are only prohibited upon the adoption of a rule pursuant to section 4(d) of the ESA, and with respect to any resident species in a state that has entered into a cooperative agreement with the federal government, only to the extent that that state also has adopted the rule.[250] Finally, section 7 of the ESA, by mandating interagency consultation and biological analyses, attempts to "insure that any action authorized, funded, or carried out by" any federal government agency "is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat."[251]

In contrast to the Services' listing decision, which is confined to scientific data, in their designation of "critical habitat," the Services are required to take into consideration the "economic impact, and any other relevant impact, of specifying a particular area as critical habitat" and may exclude an area if the "benefits of such exclusion outweigh the benefits of specifying such area as . . . critical habitat" provided that such exclusion will not result in species extinction. 16 U.S.C. § 1533(b)(2).

248. 16 U.S.C. § 1533(f). Recovery plans are required, "to the maximum extent practicable" to include "site-specific management actions," "objective, measurable criteria" for removing the species from the ESA list, and time and cost estimates. *Id.*; *Fund for Animals*, 903 F. Supp. at 115 n.8.

249. 16 U.S.C. § 1538. "Take" is defined as to "*harass*, *harm*, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt" the same. *Id.* § 1532(19) (emphasis added). By regulation, both the FWS and NMFS have separately defined "harm" to include "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering." Endangered and Threatened Wildlife and Plants, 50 C.F.R § 17.3, § 222.102 (2003). The U.S. Supreme Court upheld the validity of the FWS regulation in *Babbitt v. Sweet Home Chapter*. 515 U.S. 687, 708 (1995). The regulatory definition of "harass" is arguably broader than "harm" encompassing not only acts but also "omission[s]" and requiring only the "likelihood of injury" rather than actual injury. 50 C.F.R. § 17.3. Moreover, the terms "wound" and "kill" suggest an emphasis on consequences in addition to intent (e.g., hunt, shoot, trap, etc.). *See* 16 U.S.C. § 1531(18). Exceptions to the broad taking prohibition include takings for scientific purposes and to enhance species survival or if such taking is "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." *Id.* § 1539(a)(1).

250. 16 U.S.C. § 1533(d).

251. *Id.* § 1536(a)(2). The Services have jointly defined "jeopardize the continued existence of" as engaging in an action that "reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." Interagency Cooperation, Endangered Species Act of 1973, 50 C.F.R. § 402.02 (2003). Such action includes continuing action. Tenn. Valley Auth. v. Hill, 437 U.S. 153, 173–74, 184 (1978). Each federal agency proposing to undertake action shall "request of the Secretary [of the Interior or Commerce, as appropriate] information whether any species which is listed or proposed to be listed *may be present* in the area of such proposed action. If the Secretary advises . . . that such species may be present, such agency shall conduct a biological assessment for the purpose of identifying any endangered

B. ESA Listing of Atlantic Salmon

The Services have followed a tortured track in their regulation of wild Atlantic salmon, reversing their position on more than one occasion. This story begins in 1991, when the FWS designated Atlantic salmon in five Maine rivers as candidate species under the ESA.[252] In 1994, in response to petitions to list Atlantic salmon under the ESA, the Services found sufficient scientific information to suggest that listing may be warranted.[253] In 1995, the Services conducted a joint status review of the species. That review led the Services to conclude that D.P.S.[254] of Atlantic salmon on seven Maine rivers—the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap and Sheepscot Rivers—should be listed,[255] and as a result, the Services proposed to list the seven-river Atlantic salmon D.P.S. as a threatened species.[256]

By proposing to list the Atlantic salmon D.P.S. as a threatened rather than an endangered species, the Services were able to include within the proposal a special rule promulgated pursuant to section 4(d) of the ESA[257] that would permit the State of Maine to adopt a plan, subject to the approval of the Services, that would define the measures to be undertaken to conserve the species.[258] After assessing the adequacy of

species or threatened species which *is likely to be affected* by such action." 16 U.S.C. § 1536(c)(1) (emphasis added). If the biological assessment identifies any such species that is "likely to be affected," formal consultation under § 1536(a)(2) is triggered. *Id.* At the conclusion of consultation, the Secretary is required to issue a biological opinion "detailing how the agency action affects the species or its critical habitat." *Id.* § 1536(b)(3). And, if "jeopardy or adverse modification is found," the ESA requires the Secretary to suggest "reasonable and prudent alternatives" to the action proposed by the federal agency. *Id.*

252. Endangered and Threatened Wildlife and Plants; Animal Candidate Review for Listing as Endangered or Threatened Species, 56 Fed. Reg. 58,804 (Nov. 21, 1991). The five Maine rivers are the Narraguagus, Pleasant, Machias, East Machias, and Dennys Rivers.

253. Endangered and Threatened Wildlife and Plants: 90-Day Findings for a Petition to List the Anadromous Atlantic Salmon (*Salmon salar*) Population in the United States as Endangered or Threatened, 59 Fed. Reg. 3067, 30673068 (Jan. 20, 1994) (to be codified at 50 C.F.R. pt. 17).

254. In general, "any distinct population segment of any species of vertebrate fish or wildlife that interbreeds when mature" may be formally defined under the ESA as a distinct population segment (D.P.S.). 16 U.S.C. § 1532(15).

255. Endangered and Threatened Wildlife and Plants: 12-Month Findings for a Petition to List the Anadromous Atlantic Salmon (*Salmon salar*) Population in the United States as Endangered or Threatened, 60 Fed. Reg. 14,410, 14,412 (Mar. 17, 1995) (to be codified at 50 C.F.R. pt. 17).

256. Endangered and Threatened Species: Proposed Threatened Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in Seven Maine Rivers, 60 Fed. Reg. 50,530 (Sept. 29, 1995) (to be codified at 50 C.F.R. pt. 17).

257. *See* 16 U.S.C. § 1533(d) and text accompanying *supra* note 250.

258. *See* 16 U.S.C. § 1533(c)(1); Endangered and Threatened Species Final Endangered Status for a Distinct Population Segment of Anadromous Salmon (*Salmon salar*) in the Gulf of Maine, 65

the State of Maine's conservation plan, and reviewing public submittals and other current information, the Services concluded that ongoing actions, including those identified in Maine's conservation plan, "have substantially reduced threats to the species [and] . . . will facilitate the rehabilitation of the seven rivers D.P.S."[259] As a result, in December 1997, the Services withdrew the proposed rule to list the Atlantic salmon D.P.S. as a threatened species.[260]

Defenders of Wildlife, a nonprofit organization, and other organizations concerned with status of Atlantic salmon, sued the Services over their decision to withdraw the proposed listing. After conducting an updated status review,[261] and presumably with insight gained on the likelihood that it would prevail on the merits of the legal challenge to its withdrawal decision given that the legal case had been fully briefed,[262] the Services reversed course again. On November 17, 1999, the Services proposed to once again add Atlantic salmon to the ESA list[263]—this time proposing that it be listed not as threatened, but as endangered, and designating the D.P.S. as the Gulf of Maine in acknowledgement of the fact that other Atlantic salmon populations could be added to the D.P.S. "if they were found to be naturally reproducing and to have wild stock characteristics."[264] On November 17, 2000, the Services adopted a final rule that found that the Atlantic salmon D.P.S. was distinct in that it met both discreteness conditions. It was (1) "markedly separated from other populations" due to "physical, physiological, ecological, or behavioral factors," and (2) delimited by international boundaries such that significant differences in the "control of exploitation, management of habitat, conservation status, regulatory

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Fed. Reg. 69,459, 69,462 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 17).

259. Endangered and Threatened Wildlife and Plants; Withdrawal of Proposed Rule to List a Distinct Population Segment of Atlantic Salmon (*Salmon salar*) as Threatened, 62 Fed. Reg. 66,325, 66,337 (Dec. 18, 1997) (to be codified at 50 C.F.R. pt 17, 425).

260. *Id.*

261. The 1999 status review was made publicly available on Oct. 19, 1999. Availability of a Status Review of the Atlantic Salmon in the Gulf of Maine Distinct Population Segment, 64 Fed. Reg. 56,297 56,297–56,298 (Oct. 19, 1999) (to be codified at 50 C.F.R. pt. 17).

262. In anticipation of a proposed listing, the parties to the case entered into a stay. Telephone Interview with Howard Crystal, Counsel for Defenders of Wildlife (Apr. 2002).

263. Endangered and Threatened Species; Proposed Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 64 Fed. Reg. 62,627 (Nov. 17, 1999) (to be codified at 50 C.F.R. pt. 17).

264. Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,462 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 17).

mechanisms exist between the United States and Canada."[265] Further, it was a significant population segment of the species and in danger of extinction.[266] The State of Maine, two of the aquaculture defendants in

265. 65 Fed. Reg. at 69,459–69,460.

266. *Id.* More specifically, the Services have identified three criteria that establish status as a D.P.S.: (a) the discreteness of a given population segment, (b) the significance of a given population segment to the species or subspecies, and (c) the conservation status of a given population segment in relation to the ESA listing standards. The Services D.P.S. policy is found at *Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under Endangered Species Act.* 61 Fed. Reg. 4722 (Feb. 7, 1996). A summary of the Services' evaluation taken almost verbatim from Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 65 Fed. Reg. at 69,459–69,462, follows (parenthetical comments added by authors):

> To be *discrete*, a population must be: 1) "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors" or 2) "delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the ESA." The Services used biogeographical and other information to define three historically distinct population segments for the Atlantic salmon: the Long Island Sound D.P.S., the Central New England D.P.S., and the Gulf of Maine D.P.S. The two southernmost D.P.S.s are now essentially extinct. The boundaries of the Gulf of Maine population segment are described as running from the Kennebec River north and including eight rivers. River-specific hatchery fish are included with wild fish as part of the D.P.S. The Services conclude from data on the straying of spawning fish, genetic information, geographic segregation, and limited stocking from outside the population segment that the Gulf of Maine D.P.S. is separate from other salmon populations. The Services found that probably no salmon are genetically pure, but that the remaining salmon are the only genetic legacy of the salmon that ranged as far south as the Housatonic River in Connecticut. The Services decided that the northern boundary of the management area has both a distinct zoogeographical and international boundary that delineates a zone of different management for the salmon. The Services conclude that both criteria for discreteness were satisfied by the Gulf of Maine D.P.S., but note that either one would suffice.
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> *Significance* means: 1) "persistence of the [D.P.S.] in an ecological setting unusual or unique for the taxon," 2) "evidence that loss of the [D.P.S.] would result in a significant gap in the range of the taxon," 3) evidence that the [D.P.S.] are abundant elsewhere (introduced), or 4) that the [D.P.S.] is different (markedly) from the rest of the species. The Services determined that D.P.S. is the southernmost population of salmon still existing. The Services note that the genome is no longer pure, but point out that important genetic resources remain within the D.P.S., because stocking was primarily from D.P.S.-derived fish. (This implies that non-D.P.S. fish could damage the genome.). The Services point out that D.P.S. genetic resources are "vitally important to the species' future survival." (This may be a reference to the potential effects of global warming, which presumably would warm river waters throughout much of the Atlantic salmon's historical habitat and thus favor the survival of salmon adapted to warmer waters.). The Services conclude that Gulf of Maine salmon are both discrete and significant, i.e. a D.P.S.
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> The *conservation status* of a given population segment refers to the abundance of that population segment relative to the ESA listing standards. The Services conclude that abundance of the Gulf of Maine D.P.S. is extremely low. Fish counts annually are in no more than tens of fish for the whole system, although the Services caution that this is not a full count. The pre-fishery abundance index (one-sea-winter or 1SW fish means fish that have not yet returned from the sea to ascend rivers and spawn) is low in spite of improving ocean habitat conditions. The Services attribute this to depressed spawning populations in the rivers and consequently few juvenile salmon entering the sea. 0+ (fry) and 1+ and 2+ (parr) numbers are also low. Smolt production is also very low. There is unexpectedly high mortality from 1+ and older parr to the smolt stage. Also, about half of the smolt that do migrate don't reach the Gulf. Most of this information comes from the Narraguagus River. A similar study was conducted on

the USPIRG cases (*Stolt* and *Atlantic Salmon*), and other parties challenged the action of the Services. A federal court, however, recently held that the Services' DPS policy was a reasonable interpretation of the ambiguous phrase, "discrete population segment," and that the record supported the listing of the Gulf of Maine DPS as an endangered species.[267]

In their listing of the Gulf of Maine Atlantic salmon D.P.S. as endangered, the Services made a number of important findings that are relevant to the issue of cultured salmon as pollutants. First, it is "unlikely that any Atlantic salmon populations in the United States exist in a genetically pure native form . . . ." However, "present populations are descendants of these aboriginal stocks, and their continued presence in indigenous habitat indicates that important heritable local adaptations still exist." Indeed, despite 128 years of stocking, "hatchery fish have not substantially introgressed with the remnant populations and genomes" of the Gulf of Maine population segment.[268]

Second, three of the factors cited by the Services in support of their decision to list the Gulf of Maine D.P.S. as endangered are: (1) a "large number of aquaculture hatchery origin juveniles" in the Pleasant River; (2) the growing threat of Infectious Salmon Anemia (ISA), a fatal viral disease;[269] and (3) the "increasing use of European strain Salmon by the Maine Aquaculture industry."[270] Indeed, studies of Northwest Ireland rivers have "clearly demonstrated" that escaped juvenile salmon have "completed their entire life cycles in the wild, including accurate homing to natal rivers and interbreeding with wild salmon."[271] Moreover, rivers in Canada and Norway that bear a resemblance to Gulf of Maine rivers "provide substantial evidence that negative impacts [from escaped farm

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the Pleasant River and found 31 smolt that had come from a commercial hatchery upstream and 676 that were evidently wild. (This implies genetic pollution of native fish by escapees from the hatchery stage of the commercial mariculture operations—that is, a release of juvenile fish before they even reach the net pens.). The Services conclude that the abundance of salmon in the Gulf of Maine D.P.S. is extremely low.

267. Maine v. Norton, 262 F.3d 13 (D. Me. 2000).

268. Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 65 Fed. Reg. at 69,465.

269. Concerns regarding the documented presence of ISA on the Canadian-side of Cobscook Bay led the Services to forgo stocking rivers with rivers-specific fish raised on the U.S.-side of that Bay.

270. Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 65 Fed. Reg. at 69,471.

271. *Id.* (citing S.L. Clifford et al., *Genetic Changes in an Atlantic Salmon Population Resulting from Escaped Juvenile Farm Salmon*, 52(1) J. FISH BIOLOGY 118 (1998)).

salmon] to the D.P.S. such as disruption of redds, competition for food and habitat, disease or parasite transfer, and interbreeding "can be reasonably anticipated to occur in Maine."[272] Further, a Canadian study of post-smolt survival was "inversely related to the density of aquaculture cages."[273] Finally, escaped farmed salmon have been found in the St. Croix, Penobscot, Dennys, East Machias and Narraguagus Rivers.[274] In upholding the listing of the Gulf of Maine DPS, the *Norton* court in turn held that the "[s]ervices were reasonable . . . in concluding that the aquaculture industry poses potentially significant threats to the continued survival of the Gulf of Maine DPS."[275]

C. *Review by the National Academy of Science*

The demarcation of wild Atlantic salmon found in the seven Maine rivers as a distinct population segment led to a call for the National Academy of Science (NAS) to review the conclusions of the Services.[276] The Services' findings were generally seconded by the important report issued by the NAS in the spring of 2002 on the Gulf of Maine D.P.S.[277] The National Resource Council's Committee on Atlantic Salmon in Maine found that North American and European stocks were "clearly genetically distinct," and there was "surprisingly strong" evidence of genetic diversity between Maine and Canadian stocks, and even "considerable genetic divergence" among populations on the eight Maine rivers.[278] Moreover, the NRC panel concluded that farmed fish differ in genetic makeup from the Gulf of Maine D.P.S. due to non-native strains, selection by breeders (growth rate, fat content, disease resistance, and delayed maturity), and "inadvertent selection by the novel environment (e.g., reduced fright response, disease resistance, and altered aggressive behaviors)."[279] Particularly important for present purposes, the NRC noted that researchers estimate a 3% escape rate in British Columbia.[280] For Maine, a 3% escape rate of farmed salmon

272. *Id.* at 69,477.
273. *Id.* at 69,478 (citations omitted).
274. *Id.*
275. Maine v. Norton, 262 F.3d 13 (D. Me. 2000).
276. GENETIC STATUS OF ATLANTIC SALMON, *supra* note 7, at 1.
277. *Id.*
278. *Id.* at 4.
279. *Id.* at 20 ("Those same traits may not be adaptive in the wild.").
280. *Id.* at 21 (citing M. Gross, *Net Risk: Assessing Potential Impact of Fish Farming on BC's Wild Salmon*, *in* GHOST RUNS: THE FUTURE OF WILD SALMON ON THE NORTH AND CENTRAL COASTS OF BRITISH COLUMBIA (B. Harvey et al. eds., 2002)).

translates to 180,000 escapees per year from net pens.[281] Even if one assumes an "escape rate as low as 0.17 percent, which would be impressive," there still would be "10,000 escapees per year, 100 times the number of adults that returned to spawn" in the Gulf of Maine rivers in 2000.[282]

The genetic impact of mariculture escapees on wild salmon thus may include the introduction of foreign genetic material to the wild genome. This foreign material may be from other parts of the Atlantic salmon's range (the use of Norwegian sperm stock for example in U.S. mariculture operations)[283] or it may be altered genetic material and include parts of the genome of fish other than the Atlantic salmon. The first genetically engineered animal in the U.S. awaiting U.S. Food and Drug Administration approval, so that it may be farmed commercially, is a Chinook salmon with Ocean pout genes that cause it to grow seven times faster than normal.[284] It is not inconceivable that genetically engineered Atlantic salmon may soon exist and be awaiting approval for mariculture operations in the United States.

D. Conservation Measures in Support of Wild Atlantic Salmon

In addition to undertaking regulatory measures, such as listings that have legal implications, the Services have also undertaken conservation measures in relation to wild Atlantic salmon. Specifically, the Services maintain a hatchery program for the Gulf of Maine D.P.S. at Craig Brook National Fish Hatchery in Orland, Maine.[285] This program is

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281. *Id.*

282. *Id.* While wild salmon likely have an adaptive advantage over farmed salmon, even a "10:1 adaptive advantage" may not be sufficient to overcome a 100:1 numerical disadvantage. *Id.* In *Marine Envtl. Consortium v. Wash. Dep't of Ecology*, the court affirmed the Washington State Pollution Control Hearings Board's findings on the legal and biological effect of the escape of farmed Atlantic salmon on the Pacific coast. No. 99-2-00797-0, slip op. ¶ II.VII. (Wash. Super. Ct. Dec. 1, 2000). *See also supra* notes 167–181 and accompanying text. The Board found, and the court affirmed, that the release of farmed salmon "while undesirable, does not pose a significant threat to native salmon" in terms of competition, predation, disease transmission or hybridization. Yet, the Board found, and the court affirmed that "regular and large releases such as occurred in 1996 [105,000 Atlantic salmon] and 1997 [369,000 Atlantic salmon] could constitute a significant threat to Pacific salmon." *Marine Envtl. Consortium*, ¶ I.IX. *See also supra* Part III.C.

283. GENETIC STATUS OF ATLANTIC SALMON, *supra* note 7, at 20.

284. *See* Jane Kay, *"Frankenfish" Spawn Controversy: Debate Over Genetically Altered Salmon*, S.F. CHRON., Apr. 29, 2002, *available at* http://sfgate.com/cgi-bin/article.cgi?f=/c/a/2002/04/29/MN155761.DTL.

285. Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,461 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 17).

river-specific,[286] meaning that fish from a given river are used as broodstock for that same river. Currently, fish from five rivers in the Gulf of Maine D.P.S. are used in the hatchery program.[287] Fish from a sixth river also were captured as broodstock, but were destroyed due to the presence of Salmon Swimbladder Sarcoma Virus.[288] A second attempt is being made to establish a broodstock population for this river.[289] Although fry were first stocked from this hatchery program into some rivers in 1996,[290] because a minimum of four years are needed to evaluate the success of the stocking,[291] as of 2000, the effect of the river-specific stocking program had yet to be evaluated.

Within this hatchery program, the Services have established breeding protocols to help "ensure that genetic integrity is maintained."[292] Nevertheless, the genetic makeup of stocked fish is rarely the same as wild fish, even if the stocked fish are part of a river-specific breeding program.[293] There are two reasons for this. One is that it is nearly impossible to avoid selection of any kind in a hatchery operation. That is, hatchery fish by definition survive according to their fitness in relation to selection pressures within the hatchery, which may be different from selection pressures in the wild.[294] For example, aggressive feeding without regard to the presence of other fish may be a beneficial behavior in a hatchery, but in the wild, it may unnecessarily expose young salmon to predators. The second reason is that, even in the absence of differing selection pressures between hatcheries and the wild, the abundance of the specific genome of the hatchery brood-stock is amplified with respect to other segments of the overall genome in the wild—that is, in the hatchery, broodstock will on average contribute more offspring to the overall gene pool than will wild salmon, and thus the diversity of the overall genome is in effect narrowed.[295]

286. GENETIC STATUS OF ATLANTIC SALMON, *supra* note 7, at 18.
287. 65 Fed. Reg. at 69,461.
288. *Id.*
289. *Id.*
290. *Id.*
291. The fry should spend at least two years in freshwater and two years at sea before returning to spawn or four years total from the time of stocking to the time of returning to spawn.
292. 65 Fed. Reg. at 69,467.
293. ALTUKHOV ET AL., *supra* note 41, at 252–60.
294. *Id.*
295. *Id.*

V. THE POTENTIAL FOR DISEASE TRANSMISSION FROM CULTURED TO WILD STOCKS

The parallel harms that result from the intentional release of stocked fish and the accidental release of cultured fish suggest that a narrow policy intervention focused solely on aquaculture would be incomplete. Although the first cases that have considered fish as pollutants have arisen as a result of accidental releases in the context of aquaculture and power production, even fish that are intentionally released into the environment, often at the behest of recreational fishers, can negatively impact wild populations. For example, native species reared in fish hatcheries have the potential to genetically pollute the genome of wild fish stocks, while both native and exotic species raised in fish hatcheries, like aquaculture stocks, may transmit pathogens and viruses to wild stocks. One such disease that scientists have studied extensively in freshwater salmonid[296]populations is whirling disease.

Whirling disease is a syndrome of spinal deformities and erratic behaviors, such as tail-chasing, caused by the presence of a parasite, *Myxobolus cerebralis*, in trout.[297] Whirling disease can be fatal to juvenile trout.[298] The introduction of whirling disease has potential to decimate wild trout populations.[299] For example, in a series of experiments on the upper Colorado River in Colorado, young brook trout and cutthroat trout exposed to the parasite in the field suffered 85 percent or higher mortality within four months of exposure.[300] A reduction of a similar magnitude, 90 percent, was evidenced on Montana's Madison River, with the population stabilizing at a level that represents 10 percent of its historical abundance.[301]

A review of the relevant literature by Jerri L. Bartholemew and Paul W. Reno shows that whirling disease has now been documented in 22 of the 50 states.[302] In addition to being widespread the presence of whirling

296. The *Salmonidae* family is composed of salmon, trout, and char species.

297. R. Barry Nehring et al., *Whirling Disease Investigations*, COLO. DIV. OF WILDLIFE, FED. AID PROJECT F-237-R8, 2 (2001) (on file with author).

298. *Id.* at 1.

299. *Id.*

300. K.G. Thompson et al., *Field Exposure of Seven Species or Subspecies of Salmonids to* Myxobolus cerebralis *in the Colorado River, Middle Park, Colorado*, 11(4) J. AQUATIC ANIMAL HEALTH 312–29 (1999).

301. D.C. Downing et al., *Relation of spawning and rearing life history of rainbow trout and susceptibility to* Myxobolus cerebralis *infection in the Madison River, Montana*, 14(3) J. AQUATIC ANIMAL HEALTH 191–203 (2002).

302. Jerri L. Bartholemew & Paul W. Reno, *The History and Dissemination of Whirling Disease*,

disease has now been confirmed in some of the nation's most important fisheries, including Pyramid Lake in Nevada and the AuSable River in Michigan.[303] In 1998, whirling disease infection was documented in a population of Yellowstone Lake cutthroat trout.[304] Those fish represented the world's largest native cutthroat trout population, residing in the largest intact zone of lake cutthroat trout habitat.[305] In western states, the spread of whirling disease has been particularly notable. Whirling disease is present in all coldwater drainages in Colorado, with the exception of the Animas and North Republican rivers.[306] In Montana, whirling disease has been confirmed in 87 waters in the Beaverhead, Gallatin, Madison, Bighole, Bitterroot, Blackfoot, Jefferson, Swan, Clark Fork, Missouri, Sun, Flathead, and Yellowstone river drainages.[307]

Whirling disease is not native to North America.[308] Whirling disease arrived in North America through the importation of frozen rainbow trout; it was first documented in Pennsylvania from where it rapidly spread to other states.[309] Vectors for the spread of M. cerebralis include import of fish and fish products as well as oligochaete worms imported as food for ornamental fish.[310] The shipment of fish from one location to another is the most likely vector for the spread of whirling disease in the United States.[311] Fish hatcheries are perhaps the most important vector for the spread of whirling disease.

The private and public hatchery system throughout the U.S. is an important component of the shipment of fish from one location to another. Of the 22 states in which whirling disease has been documented, 20 have fish culture facilities which are either currently

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in Whirling Disease: Reviews and Current Topics, 29 AM. FISHERIES SOC'Y SYMP. 10–12 (2002).

303. *Id.* at 10–12.

304. *Id.*

305. YELLOWSTONE NATIONAL PARK NEWS RELEASE, *Anglers Need to Catch Lake Trout in Yellowstone Park* (Sept. 5, 2002), *available at* http://www.nps.gov/yell/press/02106.htm. The subject of this press release, the threat posed to Yellowstone Lake Cutthroat trout by introduced Lake Trout, is itself illustrative of the problems posed to native populations of fish by introduced species.

306. *See* Bartholemew, *supra* note 302, at 10–12.

307. *Id.* at 10–12.

308. *Id.* at 8.

309. *Id.* at 13.

310. *See id.* for the spread of whirling disease through the importation of fish and fish products. *See* J.M. Lowers & J.L. Bartholomew, *Detection of Myxozoan Parasites in Oligochaetes Imported as Food for Ornamental Fish.*, 89 J. OF PARASITOLOGY 84–91 (2003) (the detection of whirling disease spores in fish food).

311. Eric P. Bergersen & Dennis E. Andersen, *The Distribution and Spread of* Myxobolus cerebralis *in the United States*, 22 (8) FISHERIES 6–7 (1997).

positive for whirling disease or which have been historically positive.[312] In 1998, whirling disease was found in 12 of 15 of Colorado's trout hatcheries and, through unwitting introduction to previously uninfected waters, had killed off 90 percent of the trout in six of Colorado's most important trout rivers.[313] Whirling disease is thought to have arrived in Colorado through a shipment of diseased fish from a private hatchery in Idaho.[314] In some cases, the detection of whirling-disease positive fish in fish hatcheries has led to extreme management measures. In Utah, the sacrifice of all potentially affected fish followed the discovery of whirling-disease in a state hatchery.[315] The response of the Utah Division of Wildlife Resources to the presence of whirling disease in a state fish hatchery is one example of de facto treatment of live fish as pollutants by fisheries managers.

The transmission of whirling disease from hatchery fish to wild stocks suggests that the ecological impacts that stem from the introduction of non-wild fish populations neither are limited to salmon net pen operations nor the accidental release of fish from aquaculture operations, but rather, transcend the line between accidental and intentional fish releases.[316]

VI. POLICY IMPLICATIONS AND CONCLUSIONS

The recent descriptions of escaped Atlantic salmon as pollutants are an indication that we have reached a turning point in our understanding of fisheries management. The concept of fish as pollutants, especially if it is solidified and extended through further court cases, has the potential to restructure not only our thoughts about regulation of the increasingly important U.S. aquaculture and mariculture industries, but also our management of fishes in inland and coastal waters in general. This is especially true for the type of expensive sport fish stocking programs that have been criticized by some fisheries managers and scientists for more than a century as ineffective at best and destructive at worst to

312. *See* Bartholemew, *supra* note 302, at 10–12.

313. *See* Associate Press, *Colorado Trout Dying of Whirling Disease*, N.Y. TIMES, Dec. 29, 1998, at A14.

314. *Id.*

315. *See* Bartholemew, *supra* note 302, at 19.

316. The issue of disease transmission (in this case, infectious salmon anemia (ISA), infectious hepatopoietic necrosis (IHN), and infectious pancreatic necrosis (IPN) rather the whirling disease) from cultured stocks of Atlantic salmon, whether they are native or non-native, to the endangered Gulf of Maine Atlantic salmon D.P.S. is an additional cause of concern.

natural assemblages of game and other fish. Critics of such programs have historically lacked the legal and scientific tools with which to argue their case. The recent decisions in the USPIRG cases, along with the endangered species listing of Atlantic salmon, the National Academy of Sciences report, and the increasing evidence of disease transmission between hatchery and wild stocks, may provide the philosophical, scientific and legal basis with which to challenge the status quo of fisheries management.

The purpose of the CWA is expressed in section 101(a): "The objective of the Act is to restore and maintain the chemical, physical, and *biological integrity* of the Nation's waters."[317] Section 301(a) of the CWA states that "[e]xcept as in compliance with this section and sections 302, 306, 307, 318, 402, and 404 of this Act, the discharge of any pollutant by any person shall be unlawful."[318] As noted earlier, the term "pollutant" includes "biological materials."[319] The only exception relevant to fish hatcheries are allowable discharges under the NPDES permit system. The purpose of the NPDES permit system, defined in 40 C.F.R. § 131.2, provides "water quality standards should, wherever attainable, provide water quality *for the protection and propagation of fish, shellfish and wildlife* and for recreation in and on the water and take into consideration their use and value of public water supplies, *propagation of fish, shellfish, and wildlife*, recreation in and on the water, and agricultural, industrial, and other purposes including navigation . . . ."[320]

Clearly, the phrase "biological materials," as it is normally understood, would include fish.[321] From this, it ought to be inescapable that the discharge of fish from mariculture facilities, fish hatcheries and fish hatchery trucks that are already defined as point sources for the purposes of the CWA should be regulated under the NPDES permit system. Water quality standards that do not address the discharge of live fish as pollutants from NPDES-regulated facilities are incomplete in light of the expressed purpose of both the CWA and NPDES permit system and evolving science. A large number of federal and state fish

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317. 33 U.S.C. § 1251(a) (2000) (emphasis added).

318. *Id.* § 1311(a).

319. *See id.* § 1362(6); *see also supra* notes 182–94 and accompanying text.

320. Water Quality Standards, 40 C.F.R. § 131.2 (2003) (emphasis added); *see also* 33 U.S.C. § 1251(b).

321. "Biological" is defined as "of, relating to, caused by, or affecting life or living organisms," THE AMERICAN HERITAGE COLLEGE DICTIONARY 139 (3d ed. 1993). "Material" is defined as the "substance or substances out of which a thing is or can be made." *Id.* at 837.

hatcheries are NPDES-regulated facilities, and yet, do not have provisions in their permits authorizing the unintentional or intentional release of fish into waters of the United States.[322] To the extent our interpretation of the law is correct, this is equivalent to discharging dioxins or any other type of pollutant from a point source into waterways without a NPDES permit. The CWA and NPDES statements of purpose are perhaps the strongest indication that the discharge of fish should be regulated under the NPDES permit system. It is difficult to conceive of a more radical alteration of the "biological integrity" of a body of water as expressed in the CWA statement of purpose than the introduction of fish. How can an introduction of fish that negatively impacts the native biofauna "take into consideration . . . [the] propagation of fish, shellfish, and wildlife" as expressed in the CWA and NPDES statements of purpose?

Turning more specifically to the USPIRG cases, they are for the most part well-reasoned. Although there is no legislative history to shed any light on the congressional intent in defining the word "pollutant" to include the term "biological materials," mariculture escapees—being living organisms—fit neatly within the common meaning of that term,[323] and hence, are "pollutants" within the meaning of the CWA.[324] However, by considering only non-North American Atlantic salmon to be "non-native" and by confining its holdings to "non-native" farm-raised Atlantic salmon, the court made two errors.

First, as a factual matter, farm-raised Atlantic salmon of Canadian origin are not native to the Gulf of Maine. As noted in Part IV, the National Academy of Science as well as federal fish agencies found subtle, yet important, genetic distinctions between wild Atlantic salmon originating in the Gulf of Maine and those that spawn in Canadian waters.[325] Moreover, even farm-reared native fish differ from their wild cousins because of breeder selection and the novel environment posed by net pens.[326] Second, the court appears to have placed emphasis on the word "pollutant," in narrowly tailoring its holding, when the operative

322. *See, e.g.*, Gary Whelan, *supra* note 216.

323. *See supra* note 321.

324. 33 U.S.C. § 1362(6).

325. GENETIC STATUS OF ATLANTIC SALMON, *supra* note 7, at 36; Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,459–69,460 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 17).

326. *See supra* note 280 and accompanying text.

phrase is "biological materials."[327] This latter term does not in itself have the negative connotation of the word "pollutant." Thus, the addition of any living organism, including fish from mariculture operations, fish hatcheries or fish trucks, to the waters of the United States from a point source falls neatly within the ambit that the CWA seeks to regulate.

It is true that in an unpublished order a Washington superior court affirmed a state administrative board order's that held that the "inadvertent release of Atlantic salmon" at the then existing escape level did not cause "pollution," thereby supporting the issuance of discharge permits at Atlantic salmon aquaculture facilities.[328] Yet, for a number of reasons that case is of limited value to the question of escapes under federal law. First, the case was decided on the basis of state, rather than federal, law. Moreover, the state law in question defines "pollution" to mean, *inter alia*, "contamination . . . or alteration of the physical, chemical or biological properties" of, or the discharge of a "substance" into, any waters of the state "as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to the public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life."[329] In other words, to demonstrate that escaped Atlantic salmon are "pollution" under Washington state law, a complainant must establish not only a biological alteration of or discharge of a substance into state waters, but that such alteration or discharge causes a "nuisance" or otherwise renders the waters "harmful, detrimental or injurious" to native salmonoid species.[330] In comparison, under the CWA, the EPA or a citizen plaintiff as appropriate, must only demonstrate the discharge of material that is

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327. U.S. Pub. Interest Research Group v. Atl. Salmon of Me., LLC, 215 F. Supp. 2d 246–49 (D. Me. 2002) 33 U.S.C. § 1362(6).

328. Marine Envtl. Consortium v. Wash. Dep't of Ecology, No. 99-2-00797-0, slip. op. at 2, ¶ II.VIII. (Wash. Super. Ct. Dec. 1, 2000).

329. "Whenever the word 'pollution' is used in this chapter, it shall be construed to mean such contamination, or other alteration of the physical, chemical or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to the public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life." WASH. REV. CODE § 90.48.020 (2002).

330. *Id.*; *cf.* Tiegs v. Boise Cascade Corp., 83 Wash. App. 411, 416, 420, 922 P.2d 115, 119–20 (1996), *aff'd*, Tiegs v. Watts, 135 Wash. 2d 1, 954 P.2d 877 (1998) (jury instruction following the above construction of the definition held proper); *see also* Marine Envtl. Consortium v. Wash. Dep't of Ecology, No. 99-2-00797-0, slip op. at 2, ¶ II.VIII. (Wash. Super. Ct. Dec. 1, 2000).

"biological" in nature. In other words, no showing of harm is required under federal law.[331] Lastly, as an unpublished lower court state order, the finding and conclusions are without value as precedent.[332]

Regardless of the legal merits of a finding that the escape of net pen-raised Atlantic salmon constitutes the discharge of a pollutant from a point source, we are left with the question of whether regulating such escapes is good policy from a social and scientific vantage point. One might reasonably ask: do we really want to think of a few Atlantic salmon escaping from a fish farm as pollutants?

The short answer is yes. There is sufficient evidence that escaped Atlantic salmon negatively affect wild salmon to consider the escapees pollutants. The long answer is that in order to fully appreciate the effect of escaped Atlantic salmon on wild Atlantic salmon, it is important to consider this question within the context of the life cycle and historical abundance of wild Atlantic salmon including their current legal status, their value as food and sports fish, their cultural significance, the impact of anthropogenic factors on salmon abundance, and the development of Atlantic salmon and other mariculture operations in the United States. Finally, because the decision in the USPIRG cases (and the *APHETI* case as well) may affect the regulation of other aquaculture ventures and other fish management practices, we might want to consider the history of aquaculture in general in the United States, including food production, the aquarium industry, and trout and other game fish stocking programs, and ask ourselves if it also makes sense to think of other species of fish as pollutants.

As an alternative to present Atlantic salmon farming practices in Maine, we recommend that: (1) Atlantic salmon hatchery operations be relocated to rivers outside of the Gulf of Maine D.P.S. so that maricultured salmon are not biologically imprinted with the same

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331. In *Public Utilities District v. Department of Ecology*, the Washington Supreme Court stated that the definition of "pollution" under state law "is, if anything, broader than the definition of 'pollution' in the Clean Water Act" in the context of a case involving the establishment of minimum instream flows. 146 Wash. 2d 778, 820, 51 P.3d 744, 765 (2002). This statement, however, addressed the fact that Washington explicitly regulates "physical" changes to waters while the CWA does not. The court did not address the issue of harm. The conclusion that in some respects Washington's discharge permit program is less encompassing than the federal program is a peculiar result given that under the CWA, state programs are supposed to be at least as stringent as the federal program. *See supra* note 135 and accompanying text.

332. Dahl-Smyth, Inc. v. City of Walla Walla, 148 Wash. 2d 835, 839 n.4, 64 P.3d 15, 17 n.4 (2003) (en banc) ("We do not suggest that this or any other unpublished opinion should be relied on as precedent."); *cf.* WASH. R. APP. P. 10.4(h) (prohibiting the citation of unpublished opinions as authority).

biological markers as endangered wild populations; and (2) offshore mariculture facilities be moved out of state jurisdictional waters and into that portion of the territorial sea that is exclusively federal (three to twelve nautical miles from shore) and the U.S. Exclusive Economic Zone (EEZ) that extends to 200 nautical miles from shore in order to minimize potential ecological harm and prevent water use conflicts. Unfortunately, inasmuch as it is an impediment to the movement of mariculture further from the shore, the current regulatory framework for U.S. mariculture is incompletely developed.

State regulation of mariculture is inconsistent, with such diverse rules as a blanket prohibition of finfish farming in Alaska, a submerged lands lease from the Department of Agriculture and approval by the State Cabinet required in Florida, and aquaculture siting on a local and county level in Texas and Washington respectively.[333] Federal statutes and their administering agencies with potential regulatory authority over mariculture operations include: the CWA; sections 102 and 304 of the Marine Protection, Research and Sanctuaries Act (MPRSA) (EPA and NOA);[334] section 10 of the Rivers and Harbors Act of 1899 (RHA) (U.S. Army Corps of Engineers);[335] the ESA, (the Services);[336] the Marine Mammal Protection Act (MMPA), (FWS and NMFS);[337] the Coastal Zone Management Act, (NOAA and affected states);[338] the Magnuson Act (NMFS and Regional Fish Management Councils);[339] the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (the EPA);[340] the Federal Food, Drug, and Cosmetic Act, (Food and Drug Administration);[341] and Outer Continental Shelf Lands Act, (Marine Minerals Service, Department of the Interior).[342] The scope of future interaction among these statutes, their administering agencies, and mariculture operators is not yet clear. Recommendations, however, by the United States Ocean Commission[343] on how to structure U.S. Ocean

333. *See* GOLDBURG ET AL., *supra* note 1, at 26–28.
334. 33 U.S.C. §§ 1412, 1434(d) (2000).
335. 33 U.S.C. § 403.
336. 16 U.S.C. § 1531.
337. 16 U.S.C. § 1371.
338. 16 U.S.C. § 1456.
339. 16 U.S.C. § 1801–83.
340. 7 U.S.C. § 136(a)–(y).
341. 21 U.S.C. §§ 301–397.
342. 43 U.S.C. §§ 1331–1356. *See* GOLDBURG ET AL., *supra* note 1, at 20–22; B. CICIN-SAIN ET AL., CENTER FOR THE STUDY OF MARINE POLICY, DEVELOPMENT OF A POLICY FRAMEWORK FOR OFFSHORE MARINE AQUACULTURE IN THE 3–200 MILE U.S. OCEAN ZONE (2000).
343. U.S. OCEAN COMM'N, *at* http://www.oceancommission.gov (last visited July 27, 2003);

policy institutions and more specific work by an interdisciplinary research team that is presently developing an operational framework—administration, planning, site assessment, leasing, permitting, environmental reviews, monitoring, compliance and enforcement—for offshore aquaculture in federal waters will be forthcoming in 2003.[344]

From the mariculture industry's standpoint, moving into federal waters would have several benefits. To begin with, whatever regulatory framework is eventually adopted for federal waters, it will provide the industry with a more consistent regulatory environment than presently exists as it moves from one state jurisdiction to another, up and down the Atlantic, Pacific, and Gulf Coasts. Moreover, federal waters are unique because state law does not apply to them, and thus, for the most part, mariculturalists operating in federal waters can avoid potentially conflicting and duplicative federal and state regulations.[345] In the future,

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Information on the Pew Oceans Commission, *available at* http://www.pewoceans.org (last visited July 27, 2003) (sponsored by a non-governmental organization).

344. The website of the research project is: http://darc.cms.udel.edu/sgeez (Sept. 16, 2002). A final report is anticipated in late summer or early fall, 2003. An earlier report can be found at http://darc.cms.udel.edu/sgeex1final.pdf (last accessed July 28, 2003). The research team includes one of the co-authors. The life cycle of the Atlantic salmon presents policymakers and fisheries managers with an additional chore—the necessity of managing the species cooperatively across state, national and international jurisdictional boundaries. For example, however the Gulf of Maine D.P.S. might be protected in Maine's rivers as a result of its endangered species status, its protection under U.S. regulations from commercial or recreational fishing impacts outside the U.S. EEZ is more problematic. For example, the ESA prohibition against takes on the high seas applies only to persons "subject to the jurisdiction of the United States." 16 U.S.C. § 1538(a)(1) (2000). Likewise, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), (available at http://www.cites.org/eng/disc/text.shtml and implementing U.S. law and 16 U.S.C. § 1538(a)(1)(c)–(d)) is directed toward prohibiting international trade in wild animals and plants that threatens their survival rather than prohibiting the taking of endangered species. In addition, because there is some gene flow between salmon populations on both sides of the Atlantic, a change in the genome in one part of the salmon's range might manifest itself in a separate stock some distance from the first-affected population.

345. Section 401 of the CWA, 33 U.S.C. § 1341, requires a federal permit applicant to receive certification from a state that its discharge is in compliance with state water quality standards. Section 401, however, is not applicable to discharges that occur in federal offshore waters because the jurisdictional reach of the states under Section 401 only extends three miles offshore. *See id.* § 1362(8); Natural Resources Defense Council v. EPA, 863 F.2d 1420 (9th Cir. 1988). It is true, however, that even if mariculture operations occur in federal waters, some state laws and programs may still have bite. For example, section 307 of the Coastal Zone Management Act (CZMA) requires federal permit applicants to obtain state certification that any permitted action that will affect land uses, water uses or natural resources of a state's coastal zone are consistent with that state's coastal zone management plan. 16 U.S.C. § 1456. States also, for example, could require a permit to transport live fish through state jurisdictional waters. *See, e.g.*, ALASKA ADMIN. CODE tit. 5, § 41.005 (1988); CONN. GEN. STAT. ANN. § 26-57 (West 1991). Finally, states may participate in permit and lease development through the environmental evaluation and public participation process mandated by National Environmental Policy Act (NEPA). 42 U.S.C. § 4332 (2000); Natural Res.

both the State of Maine and the federal government will have input into the terms and conditions of NPDES permits issued for Atlantic salmon mariculture operations in Maine coastal waters, while only the federal government would have input into NPDES permits granted for operations in federal waters. Moreover, the farther mariculture operations move offshore, the more likely they are to able avoid conflicts with other uses (e.g., the conflicts between wild and cultured salmon stocks and among mariculture, commercial fishing, oil and gas, and preservation), other users, and interested parties. Moving farther offshore also should ameliorate some of mariculture's ecological impacts. For example, the capacity of the ocean to assimilate nutrient loadings from mariculture operations should be greatly enhanced as one moves from near-shore to the wide expanse of the EEZ. Ultimately, Atlantic salmon mariculture firms and other mariculture operators will have to weigh the benefits of avoiding state regulation against the costs of moving operations to the EEZ, which include higher operating costs and the risk of storm damage.[346]

A consideration of aquaculture also points toward a broader issue and direction—that is, whether the EPA should formulate national policy and pass comprehensive rules under the CWA regulating the intentional and unintentional release of all food, sport, and all other categories of live fish from all aquaculture, mariculture, tropical fish farm, and fish hatchery facilities in the country. The EPA has thus far shown a reluctance to consider live fish as pollutants even though they appear to fit within the CWA definition of pollutants and for the most part have been recognized as such by courts.[347] This reluctance to associate stocking or releasing fish with pollution is probably shared by most fisheries managers, even those who in effect already treat live fish as pollutants through their stocking policies. To overcome the reluctance to consider fish as CWA pollutants, Congress should consider passing separate legislation *regulating* the intentional and unintentional introduction of all fish to waters of the United States. We emphasize the word "regulating" because we do not envision legislation that would prohibit all fish stocking and aquaculture operations. Indeed, it may

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Def. Council v. U.S. Dep't of the Navy, CV-01-07781 CAS (RZx) (C.D. Cal. Sept. 17, 2002) (opinion by Christina A. Snyder) (despite the presumption against extraterritoriality, NEPA applies in EEZ).

346. *See* GOLDBURG ET AL., *supra* note 1, at 5.

347. The EPA may be forced to show its hand, however, in response to comments on its proposed aquaculture effluent guidelines or in response to it draft *Aquatic Nuisance in Ballast Water Policy*. U.S. ENVTL. PROT. AGENCY (USEPA), *supra* note 133.

make little sense at this late date to prohibit, for example, the stocking of brown trout in a body of water that has been stocked annually for a century. At the same time, any stocking proposal must be sensitive to the ecosystem into which stock are proposed to be introduced and should not be used as an excuse to avoid mitigating damage to a degraded habitat.

The spread of such parasites as whirling disease, the introduction of exotic fish to aquatic ecosystems, and the escape of cultured Atlantic salmon cannot be regulated adequately through a patchwork of differing state agencies, laws, and policies. The current architects of the vast majority of fish-stocking policy are state fish and game agencies, whose perceived interests are not always in agreement with the thoughtful stewardship of aquatic ecosystems. These agencies are often pressured to provide a given number of fish in given waterways without much thought to the possible ecological effects of their stocking policies, which can include genetic damage to the native populations of fish or the spread of disease and parasites.[348]

Even when stocking policies do consider ecosystem-level effects, the nature of fish is fundamentally different than the nature of other pollutants. Most pollutants are passive, and their dynamic of spread can be more or less accurately predicted. However, live fish and parasites actively move through water systems, across oceans, and upstream. It is likely that anadromous rainbow and steelhead trout, as well as bull trout and Chinook salmon, are susceptible to infection by *M. cerebralis* and may help to spread the parasite through their migrations.[349] This in turn implies the spread of the parasites across stretches of ocean by the straying of adult fish from their natal rivers. When fish move across sovereign boundaries they pose additional management challenges.[350] Indeed, in any state fish stocking program, once the fish and their associated parasites are in the water their spread is largely out of the

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348. *See* White et al., *supra* note 2, at 116, 527–31, 533; Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmon salar*) in the Gulf of Maine, 65 Fed. Reg. 69,459, 69,460 (Nov. 17, 2000) (to be codified at 50 C.F.R. pt. 17).

349. For susceptibility of anadromous fish to infection, *see* Sarah A. Sollid et al., *Relative Susceptibility of Selected Deschutes River, Oregon, Salmonid Species to Experimentally Induced Infection by* Myxobolus cerebralis, 29 AM. FISHERIES SOC'Y SYMP. 117–24 (2002). For the possibility that anadromous fish might spread infection, see H. Mark Engelking, *Potential for Introduction of* Myxobolus cerebralis *into the Deschutes River Watershed in Central Oregon from Adult Anadromous Salmonids*, 29 AM. FISHERIES SOC'Y SYMP. 25–32 (2002).

350. *Cf.* Rebecca Bratspies, *Finessing King Neptune: Fisheries Management and the Limits of International Law*, 25 HARV. ENVTL. L. REV. 213 (2001).

hands of fisheries managers.

In many cases, live fish are *already* treated as de facto pollutants by fish and game agencies. For example, the fear of the spread of whirling disease has prompted states to take expensive and sometimes extreme measures to prevent its spread. In 1968 in Michigan, trout which had been distributed to one hundred and fifty-nine waters were destroyed because they could be traced back to three commercial facilities which tested positive for whirling disease.[351] This was typical of measures which were taken at one time in response to reports of whirling disease in the United States.[352] Recently however, such extreme measures have been modified in favor of policies designed to limit the spread of whirling disease without destroying fish.[353] Such policies include cleaning up hatcheries, limiting the stocking of infected fish, and managing affected rivers so that parasite numbers are reduced or even eliminated.[354]

Moreover, researchers and fish managers already study and employ, respectively, elaborate and expensive technologies to prevent, detect, and treat parasites. For example, DNA-based techniques are being tested so that fisheries managers will have a rapid and accurate tool with which to detect *M. cerebralis* infection.[355] Traditional tools of parasite detection may be more expensive and time-consuming, and include spore-staining techniques, mechanical and enzymatic isolation of spores, histological assessment, and immunologic methods employing the use of labeled antibodies.[356] Once detected, treatment of *M. cerebralis* infections range from treatment of the worm host[357] through drying of

351. Jerri L. Bartholemew & Paul W. Reno, *The History and Dissemination of Whirling Disease, in Whirling Disease: Reviews and Current Topics*, 29 AM. FISHERIES SOC'Y SYMP. 14 (2002).

352. *Id.* at 3.

353. *Id.* at 20.

354. *Id.*

355. Karl B. Andree et al., *Review: A Review of the Approaches to Detect* Myxobolus cerebralis, *the Cause of Salmonid Whirling Disease, in Whirling Disease: Reviews and Current Topics*, 29 AM. FISHERIES SOC'Y SYMP. 197–212 (2002).

356. *See id.* at 205 for the expense and time needed for traditional methods. For the methods themselves, please see the appropriate sections in the article. Sections are titled according to the method they describe.

357. The lifecycle of *M. cerebralis* is complex and may include several different strategies. A typical lifecycle includes the utilization of *oligochaete* hosts (typically *Tubifex tubifex* worms) and an infectious *triactinomyxon* stage that is free in the water column, in addition to the stages of the lifecycle spent within salmonid hosts. For a review of the *M. cerebralis* lifecycle see Ronald P. Hecrick & Mansour El-Matbouli, *Recent Advances with Taxonomy, Life Cycle, and Development of Myxobolus cerebralis in the Fish and Oligochaete Hosts, in Whirling Disease: Reviews and Current Topics*, 29 AM. FISHERIES SOC'Y SYMP. 45–53 (2002).

ponds, application of the lampricide agent TFM, and raising of water temperatures, to disinfection of water through chlorine, ozonation, filtration, or the application of ultraviolet light in order to attack the myxospore and actinospore stages of the *M. cerebralis* life cycle,[358] to drug treatment, habitat alteration (particularly the reduction of high-sediment areas of high *M. cerebralis* infection), reduced or targeted stocking of infected fish, and as has already been discussed, the sacrifice of infected fish, in order to treat infected fish.[359] These measures are analogous to measures which are taken in order to detect and limit the dissemination of ordinary pollutants, which raises the question: If fish are already treated as pollutants by the agencies that work with them on a daily basis, shouldn't this treatment be codified in the law?

358. *See supra* note 357 for a summary of the *M. cerebralis* life cycle.

359. For information on methods used to treat whirling disease-positive fish, see Eric J. Wagner, *Whirling Disease Prevention, Control, and Management: A Review*, *in Whirling Disease: Reviews and Current Topics*, 29 AM. FISHERIES SOC'Y SYMP. 197–212 (2002). Sections are titled appropriately according to the treatment they describe.