APPENDIX A – WITNESS SUMMARIES

Pursuant to the Court's directive during the last day of trial, (Tr. 3537:25-3538:9; 3541:7-18), Defendants have summarized the testimony of each trial witness. Witnesses who testified by deposition are identified below as well as in each summary.

Dr. R. Drew Bodaly[1]

Dr. Drew Bodaly served as the Penobscot River Mercury Study Project Leader. Tr. 927:7-10. This role involved administrative and scientific duties (Tr. 927:13-928:1), including handling the financial aspects of the study. Tr. 927:13-18; 1100:24-1101:6. Dr. Bodaly is a biologist and his work focuses on uptake of mercury in fish. Tr. 999:20-24. He acknowledged that he is not an expert in hydrodynamics, sediment cores, human health risk analysis, ecotoxicity, bird biology, or the remediation of contaminated sediment sites. Tr. 1000:4-18; 1001:6-8.

Dr. Bodaly authored Chapter 2 of the Phase II Report. Tr. 930:2-10. The purpose of Chapter 2 was to provide an indication of how much mercury in biota needed to be reduced in order to reach certain targets. Tr. 930:24-931:19. These targets were selected based on a review of the scientific literature on toxic effects in biota. Tr. 1001:15-19. However, Dr. Bodaly did not apply a specific methodology in selecting targets, and he testified that the process could have been more "rigorous." Tr. 1027:16-21. Further, he identified various problems associated with relying on literature values, explaining that "the amount of mercury it takes to produce adverse effects" varies depending on what endpoint is being studied (Tr. 1001:20-1002:6), and that different species or populations of the same species can vary in mercury sensitivity. Tr. 1004:6-1005:23; 1034:8-19. He explained that biochemical effects are controversial because they haven't been put into context of whether they will be causing reproductive impairment in wild populations. Tr. 972:7-10. He testified that, for these reasons, toxicity studies "can be more valuable than information from the literature," because they yield "information on the toxic effects of mercury on your species at your site." Tr. 1047:18-24; 1050:4-9. However, Dr. Bodaly opposed doing toxicity studies in part because he had never performed one before. Tr. 1047:2-13.

Further, Dr. Bodaly wrote in Chapter 2 that it would be unreasonable and unachievable to reduce Penobscot mercury concentrations below regional background levels. Tr. 1007:12-22; JX 6-02 at 2-4. He testified that in many Maine lakes and rivers, mercury from atmospheric deposition alone is sufficient to raise fish mercury concentrations above acceptable levels. Tr. 1008:8-12. He also testified that a specific methodology was not employed to select the reference sites from which regional background values were derived. Tr. 1010:5-9. He stated that the Study Panel did not look in detail at factors that could influence mercury concentrations between the Penobscot and reference sites, like population density and salinity. Tr. 1008:16-1010:9. Dr. Bodaly agreed with Dr. Connolly that when looking at the mercury data on a carbon-normalized basis, the difference between mercury in Penobscot sediments and in background sediments decreases. Tr. 1024:14-22.

Regarding Chapter 16, Dr. Bodaly testified that food web studies are important in determining how animals are exposed to mercury and, thus, how to reduce exposure in upper-level organisms. Tr. 1074:12-1075:10. However, there were a number of problems with the design and execution of the Penobscot food web study, including problems with timing of sampling predator and prey items, failure to directly observe bird feeding behavior, and failure to investigate where birds reside and feed in the marsh. Tr. 1078:11-1081:4; 1083:6-24; 1086:4-

[1] Dr. Bodaly's testimony can be found at Tr. 926:14-1143:1 and his CV can be found at JX 14.

1087:14; 1089:16-19. Dr. Bodaly agreed that at this point, there is not enough information to determine whether reducing total mercury in Mendall Marsh, in an attempt to impact the availability of mercury in the food chain, will result in lower mercury concentrations in birds. Tr. 1095:19-25; Tr. 1096:23-1097:10.

Dr. Bodaly testified that levels of mercury in the Penobscot have dropped significantly since the 1970s. Tr. 1048:24-1049:1. However, study flaws prohibited the Study Panel from doing a thorough analysis of temporal trends in mercury. Dr. Bodaly testified that sediment mercury concentrations vary throughout the Penobscot system (Tr. 1102:11-23), and because sediment samples were not taken at the same time every year, it was difficult to examine trends. Tr. 1101:21-1102:1. Changing sample locations for biota caused the same problem. Tr. 1102:24-1103:6. He agreed that there is statistically significant evidence of declines of mercury concentrations in mussels, and that mussels are an important species for tracking trends. Tr. 1051:12-18.

Dr. P. Michael Bolger[2]

Dr. Michael Bolger "was the lead" federal government expert on methylmercury risks in seafood "for many years." Tr. 2287:15-17. A board-certified toxicologist, Dr. Bolger has been doing "exposure, hazard, safety, risk assessment" of chemical contaminants in foods for over thirty years. Tr. 2281:20-24. He spent nearly twenty-five years as a toxicologist at the U.S. Food and Drug Administration ("FDA"), retiring in 2012 as Director of the Chemical Hazards Assessment staff in the FDA's Office of Food Safety, Center for Food Safety and Applied Nutrition. Tr. 2282:2-10.

Dr. Bolger led the FDA's chemical hazards assessment group from the early 1990s through his retirement. Tr. 2282:11-15. He spent a "large amount" of his time at the FDA dealing with methylmercury. Tr. 2282:22-25. He was personally involved in the 1994, 2001, and 2004 FDA fish consumption advisories related to methylmercury in seafood. Tr. 2283:5-17. He has published widely on risk assessment, exposure assessment, and methylmercury. Tr. 2286:4-21. He has received significant awards from the Society of Toxicology and Society of Risk Assessment. Tr. 2286:22-2287:5. Mallinckrodt contacted Dr. Bolger to provide expert testimony immediately after Plaintiffs disclosed Dr. Grandjean's expert report, and timely disclosed Dr. Bolger's opinions, which are "based on over 20 years of work in dealing with the hazards and risks of methylmercury in fish." Tr. 2426:6-2427:10.

Dr. Bolger testified that: (1) FDA's quantitative net benefits assessment of the risk of mercury in seafood establishes that consumption of seafood containing mercury at levels found in the Penobscot is beneficial to human health (Tr. 2348:8-2349:21); (2) safety threshold values, such as EPA's reference dose, incorporate a sizeable margin of safety such that an exceedance of a threshold value is not a dividing line between risk and no risk (Tr. 2304:1-2305:12); and (3) consumption of a single meal of seafood is not a risk factor given that the exposure of concern is steady-state blood methylmercury levels (Tr. 2317:20-2318:7), and that one serving of seafood is not sufficient to meaningfully elevate blood levels. Tr. 2318:8-15. Dr. Bolger concluded that there is no unacceptable risk to human health associated with mercury in lobster, crab, duck or eel in the Penobscot. Tr. 2438:24-2439:21.

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[2] Dr. Bolger's testimony can be found at Tr. 2281:1-2444:10. Dr. Bolger's expert report and CV can be found at JX 44.

Dr. Todd Bridges[3]

Dr. Todd Bridges testified by deposition on December 6, 2013. Dr. Bridges is a senior research scientist for the Army Corps of Engineers. JX 33 at 5:14-17. The major focus of his work over the last twenty years has been on sediment management and contaminated sediments work. JX 33 at 5:18-6:14. Dr. Bridges is academically trained as a biologist and an oceanographer. JX 33 at 7:25-8:5. He is not an engineer. JX 33 at 8:6-7. Dr. Bridges was contacted to work on the Penobscot River Mercury Study in the Spring of 2009. JX at 46:2-6. His understanding was that:

> [T]he expert panel was making a transition from investigating the processes and the science, if you will, of where the mercury was and what it was doing and where it had come from and that kind of thing to considering what actions could potentially be taken to reduce risks or improve the situation. So since, as I understood it, the science panel, the expert panel at the time didn't really have anybody in its membership who had very much experience in regards to sediment risk management or remedial activities, they wanted to put together a workshop and invite some people who had experience in the risk management field to engage with them to identify some potential opportunities or options that could be included in their effort.

JX 33 at 46:18-47:8. Dr. Bridges participated in a two-day Remediation Workshop in Bangor, Maine in June of 2009, the purpose of which was to discuss remedial options for the Penobscot River. JX 33 at 49:24-51:15. Dr. Bridges testified that "there really are a limited number of alternatives that can be considered at any of these sites, so I think it's fairly certain that we discussed those three or four alternatives that are ever [sic] potentially available at the meeting." JX 33 at 52:4-13. Those alternatives are: (1) dredging, (2) capping, (3) monitored and enhanced natural attenuation, and (4) in-situ treatment. JX 33 at 52:14-53:2.

After the meeting he had a few phone calls and email exchanges. JX 33 at 53:13-54:1. For example, the Study Panel's discussion and list of confined aquatic disposal facilities ("CADs") came directly from Dr. Bridges. JX 33 at 65:9-66:6. Dr. Bridges provided the Study Panel a list of CAD sites from a prior presentation one of his colleagues had given. JX 33 at 65:9- 66:6. Dr. Bridges also provided a list of questions for the Study Panel to consider after the 2009 Remediation Workshop to help focus the evaluation of remedial options. JX 33 at 58:7-14; DX 20. One of the points Dr. Bridges made to the Study Panel was that it was important to perform site-specific toxicological studies to understand the nature of potential risk and harm. JX 33 at 58:7-60:15. Dr. Bridges explained:

> Q. In No. 10 you note, "What is the status of the bird populations in Mendel Marsh? There is evidence that points to significant toxicity. Is this evidence supported by field data relevant to status of these populations?" Why did you ask that question?
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> A. This is an issue that is fairly common in these kinds of projects in making this transition from collecting evidence about whether or not an animal -- or plant for that matter -- but an animal that's exposed at the site is affected in some fashion by exposure

[3] Dr. Bridges' deposition transcript can be found at JX 33 and his CV can be found at JX 15.

to the contaminants. That's one piece of information. But then extrapolating that to understanding, Well, do we have less birds here, or is the population of bird species X at the site being harmed, or is there evidence for harm at that level?

Q. Does this relate to the performance of toxic effect studies?

A. Right. It relates to the interpretation of toxicological investigations. One can measure blood concentrations of mercury in birds as an indicator of exposure. Then trying to understand how that relates to the health of an individual bird would be another step; but then understanding how that translates to, again, the status, the viability of the population of that species at that site is another step. This is related to the issue objectives as well. Right? Is it your objective to protect individual birds? Is it your objective to protect the population of species X, Y, Z, the community?

JX 33 at 59:11-60:15.

Dr. Bridges testified that, based upon the fact that contamination in the Penobscot is diffuse and there are no hot spots, bank-to-bank dredging and bank-to-bank capping are not viable options. JX 33 at 176:25-179:21. Dr. Bridges explained “[i]t seems to me impractical to engage in some type of bank-to-bank dredging program in the Penobscot River for a variety of reasons. It's hard to envision how that would be undertaken. So, similarly, envisioning some bank-to-bank capping project might be hard to envision occurring, so that leaves you with What can you do?” JX 33 at 179:2-8. Dr. Bridges explained the dangers and harm of dredging: release, resuspension, residuals, and risk. JX 33 at 44:15-45:19. Dr. Bridges provided the Study Panel with the option of digging a sediment trench to capture contaminated sediment, but did not know if it would be feasible in the lower Penobscot. JX 33 at 176:25-179:21.

Dr. Aram Calhoun[4]

Dr. Aram Calhoun testified by deposition on January 17, 2014. Dr. Calhoun is a professor of wetland ecology at the University of Maine. JX 34 at 5:18-22. Her area of expertise and research focus is wetland ecology. JX 34 at 6:6-9. She has previous experience creating ecological assessments and plant community lists for estuarine and marine environments. JX 34 at 9:13-19. Dr. Calhoun does not have mercury-related experience or experience evaluating impacts of activated carbon on an ecosystem. JX 34 at 7:6-11; 11:6-8.

Dr. Calhoun was retained by the Study Panel to examine the marsh setting and determine the boundary between the tidal fresh and estuarine systems based on plant composition. JX 34 at 8:21-9:11. She was also asked to do "basic vegetation surveys" around the Study Panel's porewater sampling points, and to describe the plant communities in a broad sense. JX 34 at 9:20-10:3. Dr. Calhoun documented her community descriptions with photographs. JX 34 at 10:4-9. Her understanding was that the Study Panel would use the plant community dynamics to interpret results from the porewater sampling. JX 34 at 10:21-11:5. Dr. Calhoun's involvement with the Penobscot River Mercury Study ended when she submitted a plant list, photographs, and a table of major plant species' ecosystem preferences. JX 34 at 11:8-13. Dr. Calhoun was not asked to link her vegetation data with the porewater sampling efforts (JX 34 at 30:18-19), or to assist the Study Panel with data interpretation or report writing. JX 34 at 11:6-8. She explained that she does "not know what Cindy Gilmour collected for baseline data." JX 34 at 87:9-10. She testified about the importance of plant communities to a habitat and stated that "[a]s a scientist, I believe that before anything is done on an ecosystem that's human-mediated, one should be aware of what the potential effects are going to be." JX 34 at 69: 21-23; 90:12-22.

[4] Dr. Calhoun's deposition transcript can be found at JX 34 and her CV can be found at JX 16.

Dr. John Connolly[5]

Dr. John Connolly is an expert on fate and transport of contaminants, accumulation of contaminants in food webs, and evaluation/design of remedial alternatives, including development of mathematical models for use in evaluating remedial alternatives. Tr. 3218:5-14. He has worked on approximately thirty contaminated sediment sites domestically and internationally, including some of the largest contaminated sediment sites in the United States. Tr. 3218:20-3219:5. His work relative to the Study Panel's Phase II Report involved comparing sediment mercury concentrations in the Penobscot to regional background, examining the recovery rate of the Penobscot system, evaluating the mobile pool hypothesis as well as hot spots and erosion, modeling performance of the sediment traps, and evaluating the ability of engineers to look at remedial alternatives for the Penobscot based on information that is currently available. He concluded that mercury in the upper estuary is not highly elevated above regional background concentrations (determining that the system is only 3 to 5 times background as compared to the Study Panel's estimate of 10-20), mercury concentrations are declining such that levels should drop by half within ten to fifteen years, recovery is not inhibited by a mobile pool of sediments with a multi-decadal residence time, there is no evidence of hot spots or erosion as significant sources of mercury to the system, contaminated sediment would not stay in sediment traps due to the hydrodynamics of the river, there is no need for active remediation of the upper estuary, it is uncertain whether active remediation in Mendall Marsh is needed, and the proposed remedial alternatives presented by the Study Panel are not likely to be feasible or effective and should not be pursued. JX 45.

Dr. Connolly explained at trial that the Penobscot River is less contaminated than the Study Panel suggests, and is actually relatively close to background conditions. Tr. 3244:7-10; 3247:19-22; 3258:18-22; 3264:23-3265:4. He found that the Penobscot River has recovered significantly over the last forty years (Tr. 3232:3-4; 3273:10-21), it continues to recover (Tr. 3232:3-4), and will reach the Study Panel's targets in approximately fifteen years. Tr. 3315:18-3316:11. He testified that before recommending what can be done to accelerate recovery in the system, it is necessary to understand what is controlling recovery. Tr. 3339:13-17. He concluded that there is no evidence suggesting that hotspots or erosion are impacting recovery in the system. Tr. 3344:9-3345:9; 3346:1-3347:1; 3348:4-17. With respect to the mobile pool, Dr. Connolly testified that there is high uncertainty associated with the size of the mobile pool and whether or not there are trapping zones where portions of the mobile pool tend to congregate is "based on preliminary analysis and is … right now a hypothesis more than anything else." Tr. 3339:21-3340:2; 3340:17-21. Given the hydrodynamics of the river, contaminated sediment would not settle and stay in the sediment traps. Tr. 3360:20-23. How much solid material is coming into the pool, depositing onto the bottom of the river, and exiting out into the bay is uncertain as well. Tr. 3341:12-17. Dr. Connolly also explained that active remediation is hard to implement in an extremely complicated system like the Penobscot because of the "diffuse nature of the contamination." Tr. 3246:22-3247:9. There are no remedies that can effectively address wide-scale contamination. Tr. 3247:7-9.

5 Dr. Connolly's testimony can be found at Tr. 3217:15-3535:12. Dr. Connolly's expert reports and CV can be found at JX 45 & 46.

Unlike the Study Panel members and the experts retained by the Plaintiffs, Dr. Connolly evaluates this sort of information in the context of remedial decision-making for a living. While Plaintiffs have attempted to criticize Dr. Connolly's reference to certain data, as well as his evaluation of biota trends, he appropriately explained the limited purpose served by this information -- to provide historical context and to serve as a confirmation/check on his findings, and Dr. Connolly cautioned about uncertainties associated with this information in his testimony. Tr. 3325:3-3327:21; 3324:1-13. The broader points he makes do not hinge on this information. His opinions regarding recovery times in the system are based on the definitive data on the subject, the Mendall Marsh core data. Tr. 3293:13-19.

Dr. Connolly concluded that it would be premature to call a meeting of scientists and engineers at this time. Tr. 3372:6-3373:8. Before remedial alternatives can be evaluated, harm has to be identified and the pathways through which the contaminant gets from the environment into biota must be understood. Tr. 3367:20-24; 3368:2-8. Once this relationship is understood, engineers can begin looking at alternatives and evaluating whether various measures will reduce mercury concentrations in the biota of interest. Tr. 3368:9-18. Without this understanding, benefits of an action would be unknown, making it impossible to weigh each remedial option against negative environmental consequences. Tr. 3368:19-24; 3369:24-3370:9. What impacts any particular remedial option will have on biota, and on the system, is not understood at this time. Tr. 3369:6-12; 3371:9-11.

Dr. Charles Driscoll[6]

Dr. Charles Driscoll testified on behalf of the Plaintiffs. He is a professor at Syracuse University in the Department of Civil and Environmental Engineering. Tr. 2073:5-11. His primary focus is on teaching and research. Tr. 2192:1-3. With respect to other contaminated sediment remediation sites, Dr. Driscoll has served in a limited review capacity. Tr. 2189:3-5; 2192:13-19; 3204:14-23 (Glaza). He is not directly involved in evaluating remedial alternatives and is not in a position to provide engineering oversight. Tr. 2230:14-17; 2232:12-16.

To examine sediment mercury concentrations in the Penobscot, Dr. Driscoll used a paper by Sunderland, took National Coastal Assessment data cited in that paper, and compared it to the Study Panel's Penobscot data. Tr. 2188:18-22; 2185:10-2186:16; 2181:5-2183:2. He was unable to recall the depth of the sediment samples reflected in the data he used, and agreed that it would be misleading to compare concentrations that are buried at depth with other concentrations that could be near the surface (as he did). Tr. 2183:22-2184:22; 2185:5-9. He also testified that the current average sediment mercury concentration in the contaminated reaches of the Penobscot is lower than the target average sediment concentration at Onondaga Lake. Tr. 2190:14-2191:8. Dr. Driscoll did not do anything to evaluate mercury in biota nor did he undertake an ecological toxicity study; rather, he simply summarized the Study Panel's findings. Tr. 2209:16-23. In his evaluation of sediment recovery half times, Dr. Driscoll "did not … go back and evaluate the integrity of the cores and make a judgment on whether an individual core was disturbed or not." Tr. 2226:19-22. He agreed that this would be an important evaluation to make. Tr. 2226:23-25.

Regarding the relationship between total and methylmercury, Dr. Driscoll looked at the Study Panel's data. Tr. 2205:3-7. He testified that the relationship is not as strong in the wetlands as it is in the main stem of the estuary. Tr. 2205:8-11. He also testified that "I think that wetlands … are complicated … the methylation responds to a variety of factors. And …it's possible that … you could reduce … the inorganic mercury, and you could see a limited or even no response. I think that's certainly within the realm of possibility." Tr. 2208:8-14. With respect to the mobile pool, Dr. Driscoll testified that he believes the current understanding is somewhat uncertain. Tr. 2212:13-20. He explained that size of the mobile pool is one of the uncertainties, but that there are other important aspects of the mobile pool that are uncertain as well. Tr. 2212:21-2213:19.

He testified that "there can be unintended consequences" with active remediation. Tr. 2230:4-7. On the work performed by Dr. Gilmour, Dr. Driscoll explained that the jury is still out with respect to interpreting the activated carbon results. Tr. 2227:22-25. Dr. Driscoll only offered speculation regarding the feasibility and implementability of an active remedy in the Penobscot. Tr. 2170:15-18. He agreed that the structure of a feasibility study is a useful tool in remedial decision-making because it helps evaluate and balance risks and costs to reach a determination as to the best remedy. Tr. 2229:9-25.

[6] Dr. Driscoll's testimony can be found at Tr. 2071:12-2279:23. Dr. Driscoll's expert reports can be found at JX 47, 48 & 49 and his CV can be found at PX 124.

Despite being offered by the Plaintiffs, Dr. Driscoll's testimony actually highlights holes in the current understanding of the Penobscot system that make it inappropriate and premature to move forward into evaluating remedial alternatives without additional targeted work being undertaken.

Mr. Robert Duchesne[7]

Mr. Robert Duchesne served as a fact witness for the Plaintiffs. Tr. 1657:6-7. He does not have any technical expertise regarding mercury contamination. Tr. 1669:25-1670:2. Mr. Duchesne currently operates a bird guiding business and has written a book regarding bird watching in Maine. Tr. 1659:1-7. He guides five to eight different types of tours each year, concentrating in the northern end of the state. Tr. 1660:17-18; 1661:7-9. Generally speaking, his business has been on the upswing. Tr. 1678:8-10. Two years ago he brought a tour group to Mendall Marsh for the first time. Tr. 1662:1-7. Mr. Duchesne was bothered by the black duck consumption advisory posted in Mendall Marsh, but was unaware that there are freshwater and saltwater fish consumption advisories that apply throughout the state of Maine. Tr. 1664:22-1665:1; 1665:6-8, 1673:6-15; 1674:3-6.

In his book, "Maine Birding Trail: The Official Guide to More than 260 Accessible Sites,"[8] Mr. Duchesne testified that the goal was to provide accurate information to birdwatchers on where to find birds. DX 716; Tr. 1675:17-21. In the appendix of the book, Mr. Duchesne indicated that the Nelson's sharp-tailed sparrow is a common breeder, certain to be seen in suitable habitat in Maine. Tr. 1677:3-6. He also wrote that Mendall Marsh is one of the best sites to find Nelson's sparrows in the state. Tr. 1677:7-15.

Mr. Duchesne's testimony is not scientifically or legally significant with respect to the issues pending before the Court. Though Mr. Duchesne provides some anecdotal stories about the Nelson's sparrow (Tr. 1666:17-1667:8) and ecotourism in Maine generally, his testimony does not help frame for the Court any issues related to mercury contamination in the Penobscot estuary, how the system is recovering, and what, if anything, can be done about existing contamination.

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[7] Mr. Duchesne's testimony can be found at Tr. 1657:6-1680:3.
[8] Pertinent excerpts can be found at DX 716.

Dr. David Evers[9]

Dr. David Evers is the Executive Director and chief scientist at Biodiversity Research Institute ("BRI"), an ecological research group. Tr. 1862:24-1863:22. BRI was retained by the Study Panel to collect data on mercury levels in biota. Tr. 1869:2-8; 1935:13-19. Dr. Evers was asked by the Study Panel to perform a literature review of effects of methylmercury on wildlife. Tr. 1869:15-23. This review was included in Chapter 2, Appendix 2-2 of the Phase II Report. JX 6-2 at App. 2-2. Dr. Evers is not an expert at performing ecological risk assessments at contaminated sites. Tr. 1934:15-22.

Dr. Evers proposed a threshold blood concentration for invertivore birds of 1.2 parts per million primarily "based on a study [of] Carolina wrens." Tr. 1884:7-17; 1885:16-19. He testified that the Carolina wren study provides "knowledge and insight … on the effects of mercury to reproductive harm in songbirds," but also stated that there are "limitations and challenges and uncertainties with the Carolina wren study." Tr. 1908:18-23. Dr. Evers agreed that there are some pretty significant differences between Carolina wrens and the migratory songbirds in Mendall Marsh. Tr. 1950:14-18. He explained that different species of birds vary in sensitivity to mercury. Tr. 1939:20-24. Similarly, there can be variations between different populations of birds of the same species. Tr. 1939:25-1940:2. Sensitivity of birds to contaminants is also affected by other environmental factors. Tr. 1940:3-5. For these reasons, it is "necessary to have site-specific information on the effects of mercury to birds because site can be a variable." Tr. 1950:7-9.

BRI had proposed to study the effects of mercury at a population level in Mendall Marsh, but these studies were never approved. Tr. 1946:16-1950:4. Dr. Evers testified that it would be possible to design and implement a field study to assess potential effects of methylmercury on birds in Mendall Marsh. Tr. 1941:13-17. To assess effects of methylmercury on songbirds, BRI would primarily use reproductive endpoints, such as nest success and fledging success. Tr. 1942:2-20.[10] Additional study of Mendall Marsh songbirds would focus on measuring the percentage of adults returning to the marsh to breed, and whether the population of birds in the marsh is stable, growing, or declining. Tr. 1943:1-24; 1944:13-20. These studies would also indicate where in the food web the mercury is sourced, providing "a direct connection to the methylmercury in the marsh itself." Tr. 1944:21-1945:8.

Dr. Evers' testimony establishes that the information currently available only suggests that it is possible that songbirds and shorebirds in Mendall Marsh are being harmed. His testimony supports the position that to establish that there are significant adverse impacts to populations of birds in Mendall Marsh, and to begin to evaluate whether measures may be taken to mitigate any harm, it is necessary to conduct further study of the birds focusing on: (1) measuring reproductive endpoints; (2) measuring numbers of adults returning to or leaving the marsh as well as the number of hatchling year birds, and (3) studying how the birds are obtaining mercury through the food web.

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[9] Dr. Evers' testimony can be found at Tr. 1862:11-1964:6 and his CV can be found at JX 17.

[10] Nest success is the number of eggs from a nest that are hatched, while fledging success is the number of chicks that have fledged. 1942:21-25.

Dr. Nicholas Fisher[11]

Dr. Nicholas Fisher, a professor at the State University of New York at Stony Brook, is a member of the Study Panel. Tr. 676:17-19; 677:9-11. He is an expert in marine biogeochemistry and the focus of his work is on marine organisms and toxic contaminants. Tr. 678:12-14. He is also experienced with mercury. Tr. 678:15-679:8.

Dr. Fisher felt very strongly about the merits of conducting in-situ toxicology studies in the Penobscot and advocated for such studies for many years. Tr. 708:14-24; *see, e.g.*, DX 1. He felt that these studies were important because different species have different degrees of sensitivity to contaminants, including mercury, and there were no studies in the literature that had examined the impact of methylmercury on Nelson's sparrows or red-winged blackbirds. Tr. 711:15-25. He also felt that the issue was "tied to remediation," and explained that "[t]he question was whether in the field the organisms were just sort of limping along, but no one was dropping dead currently, and so … I needed to know … how badly impaired the resident organisms were before spending a lot of money on a remediation program." Tr. 712:1-11. He continued that if the Study Panel had evidence that organisms were dying, or that there were serious population effects, there would be a stronger argument for a large, expensive remediation program, noting that "all remediation programs are expensive." Tr. 712:12-16. Dr. Fisher also testified that "[i]f, on the other hand, I thought that the system was just sort of coughing and limping along, but it was not really that dangerously impaired, then maybe it would be best to leave … everything to clean itself up, even if it were … to take decades." Tr. 712:17-21. Dr. Fisher thought it was important "to know just how unwell" the Penobscot biota are before advising on remediation strategies. Tr. 744:17-19; 758:25-759:22. He testified that Dr. Evers would be the first person he would go to for matters pertaining to avian toxicology and that he would defer to Dr. Evers' opinion that a bird toxicity study in the Penobscot would provide helpful information. Tr. 762:19-763:7.

With respect to remedial alternatives, Dr. Fisher testified: "we recognized that the system is – the mercury is disbursed all over the place. It's not just in one location where you can dig it up and be done with it." Tr. 752:1-5. He acknowledged that every active remedy has some potential harm. Tr. 760:3-8.

Dr. Fisher's testimony is significant because it establishes the inappropriateness of finding that remediation is appropriate and starting to evaluate remedial alternatives when it is unknown whether biota in the Penobscot are actually impaired.

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[11] Dr. Fisher's testimony can be found at Tr. 676:4-783:18 and his CV can be found at JX 18.

Dr. W. Rocky Geyer[12]

Dr. Rocky Geyer is a senior scientist at Woods Hole Oceanographic Institution. Tr. 1143:18-1144:6. Dr. Geyer studies circulation processes and sediment transport in estuaries and the coastal ocean. Tr. 1144:7-12. His "number one area" of expertise is estuarine dynamics. Tr. 1146:5-10. The study of estuarine dynamics involves understanding the forces that affect movement of water in an estuary, the development of salt fronts, and the associated effects of those processes on sediment transport. *Id.* Dr. Geyer was hired by the Study Panel to characterize transport processes in the water column as they affect the movement of sediment. Tr. 1149:4-14.

Dr. Geyer discovered that the Penobscot system is very energetic because of the tidal flow through fairly constricted channels, and this provides ample energy for suspension of sediment. Tr. 1150:12-16. One of his key findings was that the Penobscot system contains a mobile pool of sediment. Tr. 1152:4-7. A mobile pool is sediment that is "continuously getting picked up and being put back down," Tr. 1154:11-16, and this remobilization may occur on a time scale of from one tidal cycle up to five years. Tr. 1152:8-22. Seasonal variation in frontal trapping of sediments and mixing of sediment over different time scales leads to homogenization of mercury in the system over time. Tr. 1152:23-1153:17.

Dr. Geyer testified that he is not one hundred percent certain how much sediment is in the mobile pool, but believes that it is probably on the order of five centimeters deep. Tr. 1155:24-1156:2. He also explained that "you're not going to come up with a definitive size, even with a perfect sampling program." Tr. 1232:12-14. The uncertainty associated with the mobile pool size estimate has to do with how much of it is subject to interannual versus seasonal variation, and Dr. Geyer speculated that this uncertainty is roughly thirty percent. Tr. 1232:15-24. He testified that it would be very difficult to quantify that variation and stated that "it's really a research question." Tr. 1234: 12-23. Dr. Geyer also explained that he does not know precisely how much sediment that enters the estuary is joining the mobile pool. Tr. 1195:3-16. Nor does he know precisely how long sediments reside in the mobile pool. Tr. 1196:3-1199:8.

Dr. Geyer said that to get a better understanding of the location and size of the mobile pool, it would be advantageous to sample during moderate river flow and take somewhere on the order of three hundred additional core samples to confirm its location. Tr. 1239:22-1240:24. More work needs to be done to survey the region between Fort Point and the south end of Verona Island to "try to come up with some sense of what the … actual mobility of that sediment is." Tr. 1241:6-10. Currently, there is a thirty percent probability that the mobile pool would not be in its expected location. Tr. 1247:8-15. This work is important because, as Dr. Geyer agreed, it would likely be a better idea to try and capture the mobile pool in the identified areas where it is located as opposed to attempting to construct a trench to trap it. Tr. 1253:3-9. Dr. Geyer expressed concern that the sediment traps would not work because the channel is so energetic. Tr. 1253:19-25. He explained that it would be hard to permanently trap sediment in that environment. Tr. 1254:1-3; 1254:12-19. Dr. Geyer agreed that altering a natural system in a way that is not fully understood is a concern. Tr. 1265:25-1266:3.

[12] Dr. Geyer's testimony can be found at Tr. 1143:2-1272:5 and his CV can be found at JX 19.

Dr. Gary Gill[13]

Dr. Gary Gill testified by deposition on December 13, 2013. Dr. Gill is a mercury biogeochemist with the Pacific Northwest National Laboratory. JX 35 at 7:21-8:4; JX 20 at 1. He has done extensive work at mercury-contaminated sites. JX 35 at 10:16-20:6. Dr. Gill provided peer review comments on a number of draft chapters of the Phase II Report. JX 35 at 6:7-22.

Dr. Gill testified as to numerous criticisms of the drafts of the Phase II Report that he reviewed. Many of Dr. Gill's criticisms related to the Study Panel's evaluation of the relationship between total mercury and methylmercury in the system. Commenting upon a Study Panel figure showing the relationship between total mercury and methylmercury in the system, Dr. Gill stated it implied that "total mercury is not always a good indicator of methylmercury levels, and that inorganic mercury is not the only parameter or the principle parameter that dictates the concentrations of methylmercury." JX 35 at 64:20-65:1. He identified a number of other parameters that drive methylmercury in a system. JX 35 at 65:2-67:10. He further testified that because methylation rates tend to vary by season, the Study Panel should have evaluated how the relationship between total mercury and methylmercury in the Penobscot varied by season. JX 35 at 44:15-46:24.

Dr. Gill made further comments related to the need for and feasibility of remediating the system. He testified that he did not see sufficient evidence to conclude that Penobscot biota get their mercury from sediments, as opposed to the water. JX 35 at 51:6-53:23. Similarly, in reviewing the draft Phase II Report chapters, it was not clear to him whether elevated levels of mercury in biota resulted from legacy mercury, on the one hand, or from ongoing mercury sources, on the other. JX 35 at 54:15-56:4. Dr. Gill thought it would have been wise for the Study Panel to have measured all ongoing sources of mercury to the system. JX 35 at 56:5-18. He testified that he did not see an adequate explanation of the criteria used to determine whether natural attenuation of the Penobscot system was too fast or too slow. JX 35 at 60:5-16; 70:2-4. He testified that it should have included considerations of ecological harm, human health, and cost. JX 35 at 108:10-110:16. He testified that the Study Panel could have done more to evaluate whether mercury was causing harm to the environment or to human health. JX 35 at 77:6-78:23.

[13] Dr. Gill's deposition transcript can be found at JX 35 and his CV can be found at JX 20.

Dr. Cindy Gilmour[14]

Dr. Cindy Gilmour was hired by the Study Panel to examine methylmercury production in the Penobscot system. Tr. 1562:21-1563:5. She drafted Chapter 11 of the Phase II Report, which related to the distribution and control of methylmercury production, and Chapter 19, which related to small plot studies of the effectiveness of in-situ amendments in reducing methylmercury risk to organisms. Tr. 1563:10-18; 1565:13-15; 1593:18-1594:9.

Dr. Gilmour testified that a number of factors contribute to high methylmercury production in Penobscot marshes, and Mendall Marsh in particular. Tr. 1563:22-1565:12. These include the amount of total mercury, the activity of microorganisms that convert mercury to methylmercury, ecosystem chemistry, the amount of dissolved organic matter, vegetation, tides, salinity, depth, elevation, and temperature. Tr. 1563:4-9; 1564:12-1565:12; 1568:19-20; 1571:1-14; 1576:12-16; 1579:6-8; 1583:7-10; 1635:9-10. She also stated that there was a great deal of spatial variability in methylmercury as a percentage of total mercury in Penobscot marshes. Tr. 1583:1-10; 1632:11-1633:1; JX 6-11 at 11-47. Dr. Gilmour's study did not address whether reducing delivery of total mercury will reduce methylmercury in the marsh. Tr. 1592:17-21. She testified that "there are many steps between inorganic mercury contamination and methylmercury exposure or uptake by animals." Tr. 1594:21-23. And, although she stated that her statistical analyses showed a proportional relationship between total mercury and methylmercury, she conceded that this does not tell us how a decrease in total mercury will affect methylmercury. Tr. 1618:12-15; 1619:4-11.

Dr. Gilmour's study found that the efficacy of activated carbon declines over time. Tr. 1600:17-19. Two years after application, none of the amendments were statistically effective. Tr. 1628:18-19. She opined that efficacy declines because of dilution of the activated carbon in the sediment and clogging of the surface of the activated carbon over time. Tr. 1601:6-22; 1622:20-24. She also acknowledged outstanding uncertainties that exist. For example, the study did not measure activated carbon's effect on mercury bioaccumulation directly. Tr. 1608:1-8. The dose necessary for activated carbon to be effective remains unknown. Tr. 1598:19-25. Some studies have shown that activated carbon may have negative effects on animals, and more data is needed. Tr. 1609:15-17; 1610:3-5; 1612:1-1613:10. Dr. Gilmour is not aware of any sites where reapplication of activated carbon has been tested or studied. Tr. 1640:5-25. And she has no sense for how many times activated carbon would have to be reapplied to maintain its efficacy over time. Tr. 1639:12-15.

Dr. Gilmour testified that there are "really no good remediation tools for mercury," and there are "big problems" with conventional tools like dredging and capping. Tr. 1591:3-1592:2. She also testified that "using activated carbon as a tool to remediate mercury is in … early days, and …there's nothing else that's good out there." *Id.* Activated carbon has never been applied on a large scale for active remediation of a contaminated mercury site. Tr. 1613:21-24. A single application of activated carbon over the entirety of Mendall Marsh would cost roughly $40 million in materials alone. Tr. 1641:20-1642:10; JX 6-19 at 19-49.

[14] Dr. Gilmour's testimony can be found at Tr. 1560:11-1646:21 and her CV can be found at JX 21.

Mr. Edward Glaza[15]

Mr. Edward Glaza is a certified professional engineer with twenty-three years of experience in contaminated site remediation work. Tr. 3063:15-17; 3066:4-23. Over the past decade, he has focused on mercury contaminated sediment sites. Tr. 3066:24-3067:2. Mr. Glaza's job entails providing technical leadership and project management on large sediment remediation projects, spanning from site investigation through technology evaluation, feasibility study, remedial design, and implementation. Tr. 3066:8-13. For example, he has a project management role at Berry's Creek, a large mercury impacted tidal estuary and marsh located in New Jersey. Tr. 3067:3-13. He is also the project manager and certifying engineer at Onondaga Lake, a large mercury contaminated lake and wetland system in New York. Tr. 3067:24-3068:11.

Mr. Glaza evaluated, from an engineering perspective, the two sediment trap recommendations proposed by the Study Panel. Tr. 3069:13-22, JX 6-23. He reviewed information currently available about the Penobscot system as well as relevant scientific and engineering literature and guidance documents. Tr. 3070:2-18. Mr. Glaza then applied the feasibility study framework to the Study Panel's proposed sediment trap remedies. Tr. 3087:23-3088:6. He chose to apply the feasibility study criteria because they make sense from a logical standpoint, they have "stood the test of time," and they are applied at every contaminated sediment site. Tr. 3090:21-3091:7; 3088:7-11. Mr. Glaza concluded that further investigation of either sediment trap remedy is not warranted. Tr. 3070:19-3071:1. He also concluded that there has been a lot of valuable information gained from the study, and this provides a basis for narrowing down the universe of remedial alternatives going forward. Tr. 3202:10-3203:1.

Mr. Glaza explained that further definition of site conditions, such as the mobile pool, and what role it plays in contributing to risk, is needed. Tr. 3201:2-6. Mr. Glaza pointed out that with respect to the mobile pool, there are significant uncertainties regarding its size and its location at any given time. Tr. 3212:23-3213:4. He explained that a complete feasibility study cannot be used to evaluate various remedial alternatives until there is "a very good characterization and understanding of the physical and chemical characteristics of the site…as well as a clear definition of the unacceptable risks, and the severity of the risks, to human health and the environment." Tr. 3089:18-3090:3. What is causing those risks must also be understood. Tr. 3090:4-8; 3090:16-17; 3140:9-11. He stated:

> [Y]ou really need to know what problem you're trying to fix. You really need to know what those risks are … you need to know how significant those risks are. And then you need to know what's causing those risks. If there is a certain level of mercury present in biota or in a receptor, how is it getting there? Is it getting there from the water column? Is it getting there from the sediment? Is it getting there from widespread, diffuse sources? Are there localized areas? Is it coming from a mudflat versus a marsh? So to get to the point where you're able to start identifying and going through an evaluation process, you really need to get to that point, and … we're certainly not at that point yet.

Tr. 3140:9-25.

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[15] Mr. Glaza's testimony can be found at Tr. 3062:19-3217:13. His expert report and CV can be found at JX 50.

Dr. Philippe Grandjean[16]

Dr. Philippe Grandjean served as an expert witness for the Plaintiffs. He is a professor and an epidemiologist. Tr. 792:12-793:22; 827:13-15. Epidemiologists investigate associations between exposure to a compound and health outcomes. Tr. 2346:8-10 (Bolger); 792:18-20. The field of epidemiology is "very distinct" from the field of risk assessment and dietary exposure assessment, where information from epidemiologists is integrated with exposure evidence to estimate risk. Tr. 2346:2-6, 2346:23-2347:1, 2346:13-22 (Keenan). Dr. Grandjean did not incorporate the elements of risk assessment into his analysis. Instead, he evaluated three species of Penobscot biota which he deemed highly relevant to human dietary methylmercury exposure: eel, lobster, and black duck. Tr. 827:16-24. He then compared the biota concentrations with reference values. Tr. 828:10-16. His evaluation of risk to human health was based on average concentrations and maximum concentrations observed in these species. Tr. 827:25-828:9; JX 51 at 5-6.

To defend his opinions, Dr. Grandjean had to ignore relevant information and pit himself against the advice of federal government agencies. As part of his conclusion that there is a health risk in the Penobscot, Dr. Grandjean testified that in sensitive populations, "even small increases should be avoided, and we should always keep the exposures below the reference dose." Tr. 886:4-12. He felt that "even a small meal of [certain species of] fish will add substantially to the total exposure … they oftentimes exceed 1 ppm." Tr. 913:3-5. To remain consistent with these opinions, Dr. Grandjean was forced to disagree that U.S. EPA's reference dose is safe/protective/suitable, and instead proposed that the dose be cut in half. *See, e.g.*, Tr. 857:24-858:18; Tr. 896:2-7. He was also forced to disagree with the U.S. Department of Agriculture's advice regarding consumption of tuna. Tr. 842:8-845:6; DX 514 at 39. However, when pressed, Dr. Grandjean conceded that "[y]ou need to understand exposure in order to assess the risk." Tr. 888:13-14. When asked whether portion size, frequency of consumption of various types of seafood, and differences between people are important to determining whether there is a risk, he stated "I don't challenge that." Tr. 888:10-23. Dr. Grandjean testified that while it would have been possible to study exposure of people to Penobscot food items, he did not do it. Tr. 821:18-23.

Further, his evaluation of the Penobscot biota failed to take into consideration some important information. For example, Dr. Grandjean acknowledged at trial that even eel outside of the aquatic influence of the HoltraChem plant are elevated above the State of Maine's action level of 0.2 ppm. Tr. 830:25-831:7. With respect to black ducks, he compared mercury concentrations in ducks wintering in the Penobscot with mercury concentrations in ducks summering in Canada. Tr. 832:11-833:16. This was inappropriate because, as the Study Panel concluded, all ducks have similar mercury concentrations at their summer breeding grounds. *Id.* Regarding lobster, Dr. Grandjean avoided acknowledging that all edible lobster meat in the north estuary is only fifteen percent higher than the EPA reference concentration of 0.230. Tr. 838:9-839:10. Further, his opinion regarding the human health risk posed by Penobscot lobster requires focusing only on the more contaminated tail meat, and ignoring the claws, which comprise one-third of the edible meat and contain half the mercury of tail meat. Tr. 834:23-835:7; 836:3-10.

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[16] Dr. Grandjean's testimony can be found at Tr. 790:5-926:12. Dr. Grandjean's expert reports can be found at JX 51, 52 & PX 13. Dr. Grandjean's CV can be found at PX 143.

Mr. Reed Harris[17]

Mr. Reed Harris testified by deposition on September 17 & 18, 2013 and March 6, 2014. Mr. Harris has expertise in mechanistic modeling of mercury and extensive experience modeling contaminated aquatic systems. JX 37 at 240:11-21; JX 36 at 11:9-16:22; 26:6-16. Mr. Harris was retained by the Study Panel to model the system to provide insight into the circulation patterns of water in the estuary. JX 36 at 18:11-16; 19:13-20:9. He undertook an extensive "multi-cell" modeling effort designed to "predict the fate of mercury coming into the system and examine factors controlling the recovery of mercury." JX 36 at 20:10-21; 26:17-27:1. Ultimately, the Study Panel made the decision to stop the multi-cell modeling work; however, Mr. Harris remained involved with the study and authored Chapter 18 of the Phase II Report. JX 6-18; JX 36 at 20:10-21.

Mr. Harris testified that the field information does not fit with the Study Panel's hypothesis regarding the size of the mobile pool. JX 36 at 51:10-52:12; 202:13-21; JX 38 at 9:9-10:12. He explained: "[i]t could be that the field estimates need to be updated and proved … but at the moment the information they have from the field is not consistent with that hypothesis." *Id.* Further, he stated that field numbers may not prove the hypothesis that the mobile pool is delaying recovery of the system because the recovery rate of the upper estuary could be faster than thirty-two years. JX 36 at 100:7-20. He gave an example using best estimates from the field of burial fluxes from particles, mass of solids being exported, and a mobile pool size of 320,000 tons, and said that "it should turn over with a half time of about five years, give or take a couple." JX 36 at 210:8-21. He also stated:

> I think you might find that there's a spectrum of particles in the system that range from very consolidated sediments that do not move well at all, some that move occasionally on a scale of years, and a mobile solids pool that moves around maybe seasonally or fairly short-term. There's probably a spectrum of all those things out there. To what extent do they interact? Maybe there are areas that are sometimes mobilized, not frequently, not part of this mobile pool of 320,000 tonnes, but maybe another mass of solids that has contamination, occasionally feeds some into the system but is going down gradually with time. Those are the kinds of things I think that should be looked at and clarified. A lot of good work has been done already to get where they are, but I don't think they're quite there to say what's really happening.

JX 36 at 205:16-206:6. Mr. Harris noted that before proceeding with remediation "there's work to be done." JX 36 at 214:21-215:13; JX 38 at 33:13-34:10, 34:15-19, 25:23-24.

Mr. Harris' deposition testimony is significant because it establishes that certain aspects of the Penobscot system are still poorly characterized.

[17] Mr. Harris' deposition transcripts can be found at JX 36, 37 & 38 and his CV can be found at JX 22.

Dr. Elizabeth Henry[18]

Dr. Betsy Henry is an expert in mercury transport fate and bioaccumulation applied to mercury-contaminated site-assessment and remediation. Tr. 2737:11-14. She has a B.S. in agronomy and a Ph.D. in engineering sciences from Harvard University. Tr. 2737:19-21. Her dissertation was on the role of sulfate-reducing bacteria in environmental mercury methylation. Tr. 2737:21-23. Dr. Henry has experience with the cleanup of mercury-contaminated sites. Tr. 2738:2-4. She is experienced in ecological risk assessment for benthic invertebrates, birds, and mammals. Tr. 2741:7-13. She was even asked by the Study Panel to conduct a peer review of the Phase I Report (which opportunity she declined). Tr. 2745:13-23.

Dr. Henry testified that ecological risk assessors should look at endpoints that are relevant to the stability of populations of organisms in the environment, including growth, reproduction, and survival. Tr. 2744:20-2745:1. With this in mind, she evaluated literature cited by the Study Panel and the mercury concentrations in Penobscot bats and concluded that mercury is not likely to pose any risk to bat populations in the Penobscot. Tr. 2750:8-2757:16. She testified that a mercury remediation program is not necessary to protect bats in the Penobscot. Tr. 2760:10-14.

Dr. Henry also evaluated Penobscot birds using the Study Panel's data. Tr. 2760:15-24. She concluded that there is no risk to fish-eating bird populations and that no remediation program is necessary to protect black duck health. Tr. 2764:3-2765:3. For a variety of reasons, Dr. Henry did not agree with the Study Panel's target level for marsh birds. Tr. 2770:15-2771:23; 2776:20-2795:8. She conducted her own review of the literature and set a higher screening value for marsh birds. Tr. 2774:8-13. She concluded that there was no risk to Virginia rails or Swamp sparrows but that Nelson's sparrow and red-winged blackbirds had average concentrations above her screening value. Tr. 2775:15-2776:16. Although, there is not enough information to conclude that there is risk to those two species, she opined that they should be subject to a risk assessment—the next step after a screening assessment. Tr. 2776:17-20; 2795:14-23. Dr. Henry described what this risk assessment might entail. Tr. 2796:11-2797:15. She testified that it is premature to make any decision regarding remediation without understanding the existence, magnitude, or severity of possible harm to marsh birds. Tr. 2796:6-10; 2809:15-19.

Dr. Henry further testified regarding the relationship between total mercury in the Penobscot system and methylmercury in birds and mammals. Tr. 2799:20-2805:1. She testified that the Study Panel does not show a direct proportionality between total mercury in sediment and methylmercury levels in biota. Tr. 2801:24-2802:5; 2803:5-9. In the absence of such a relationship, it is difficult to design a remedial program because the extent to which methylmercury levels in biota can be reduced is uncertain. Tr. 2804:9-21.

Finally, Dr. Henry testified regarding potential adverse effects of activated carbon. Tr. 2807:5-7. She testified that studies have shown that activated carbon may have adverse effects on benthic invertebrates and that it could have physical impacts on plants. Tr. 2807:16-2808:1. She does not think further testing of activated carbon is warranted this time. Any such testing should be conducted after the risk assessment of marsh birds. Tr. 2808:18-2809:7.

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[18] Dr. Henry's testimony can be found at Tr. 2736:17-2961:6. Dr. Henry's expert reports and CV can be found at JX 53 & 54.

Dr. Richard Judd[19]

Dr. Richard Judd served as a fact witness for the Plaintiffs. Dr. Judd is a member of the Maine People's Alliance and the Natural Resources Defense Counsel. Tr. 1758:12-17. He lives in Orrington, Maine. Tr. 1753:18-21. He does not have any scientific expertise regarding mercury or mercury contamination. Tr. 1755:21-23. Dr. Judd testified about kayaking and canoeing on the Penobscot River during the summer. Tr. 1757:16-23.

Dr. Judd's testimony is not scientifically relevant or legally significant with respect to the issues pending before the Court. His testimony does not help frame for the Court the issue of mercury contamination in the Penobscot estuary, how the system is recovering, and what, if anything, can be done about it.

[19] Mr. Judd's testimony can be found at Tr. 1752:24-1762:12.

Dr. Russell Keenan[20]

Dr. Russell Keenan is a toxicologist with over twenty-five years of experience in a human health and ecological risk assessment, with a focus on aquatic environments. Tr. 2445:10-20. He has worked on mercury contaminated sites since the early 1990s. Tr. 2448:23-2449:14. Dr. Keenan has expertise in dietary exposure assessment, and has performed angler surveys in Maine to gather information on how much local fish is eaten by anglers within Maine. Tr. 2445:25-2446:21. Dr. Keenan's credentials include work with U.S. EPA and the Maine DEP on human health risk assessment. Tr. 2446:22-2447:20. He has performed ecological risk assessments at a number of contaminated sites, and these have been used to make clean-up determinations. Tr. 2447:21-2448:22. With respect to the Penobscot River Mercury Study, Dr. Keenan offered opinions concerning human health risk and ecological risk to fish. Tr. 2450:16-21.

He testified that from a risk perspective "consumption of food items from the Penobscot River and the estuary is no different than the consumption of seafood items that are found in supermarkets and sold throughout Maine and throughout the United States." Tr. 2457:10-2458:10; 2459:6-12. Dr. Keenan explained the methodology for human health risk assessment at contaminated sites and stated that if a screening level assessment demonstrates potential harm, the next step is further study and investigation to make a more refined assessment of the magnitude, severity, and duration of that harm. Tr. 2459:16-2462:16. Dr. Keenan is the only witness who gathered exposure information sufficient to estimate with reasonable certainty how much food from the Penobscot might conservatively be eaten by the population. Tr. 2465:4-2477:16. He stated that "the Study Panel really just took the Maine CDC freshwater fish tissue action level and just compared all these different food items to the freshwater fish tissue action level." Tr. 2466:24-2467:2. Based on the best available information on exposure to food that might be from the Penobscot, Dr. Keenan concludes that there is no unacceptable human health risk. Tr. 2496:4-23; Tr. 2699:21-2700:1 (concluding that human consumption of black duck, eel, and lobster from the study area "don't present a risk to human health."). He stated: "to justify remediation, you would have to show … a human health risk, and we're just not seeing one here." Tr. 2496:16-18.

Dr. Keenan considered multiple lines of evidence in evaluating ecological risk to fish. He noted that natural fish populations in Maine (and elsewhere) contain mercury at or above the levels found in fish in the Penobscot. Tr. 2530:17-25. Dr. Keenan also testified that it was not appropriate for the Study Panel to recommend remedial action on the basis of comparing tissue data to screening values (Tr. 2510:16-2511:2) but, at any rate, found that fish populations are at or below even the Study Panel's own fish health screening value and are at or below the low end of the range of values thought to be associated with potential adverse effects on fish. Tr. 2686:9-2687:1. Dr. Keenan testified that best practices in ecological risk assessment suggest that in setting screening values, it is important to look at reproductive endpoints, growth, and survival, because these can impact populations. Tr. 2511:11-2512:8. Dr. Keenan adopted these best practices and applied a statistical method to derive screening values, and found that all fish are significantly below those values. He concluded that fish in the Penobscot are not at risk of adverse effects related to mercury exposure. Tr. 2536:14-16.

[20] Dr. Keenan's testimony can be found at Tr. 2444:15-2733:7. Dr. Keenan's expert reports and CV can be found at JX 55 & 56.

Dr. Carol Kelly[21]

Dr. Carol Kelly testified by deposition on November 6, 2013. Dr. Kelly has expertise in microbiology and biogeochemistry. JX 39 at 6:9-15. She spent three decades working at the "Experimental Lakes Area" in Canada, where she conducted interdisciplinary ecosystem research. JX 39 at 6:15-18. She assisted the Study Panel with QA/QC[22] work for mercury analysis in water, tissues, and sediment. JX 39 at 12:9-22. The Penobscot River Mercury Study was the first project she worked on in a QA/QC role. JX 39 at 133:4-9. To prepare for her QA/QC role, Dr. Kelly "went on the internet and read about [sic] definition of things and standard procedures." JX 39 at 138:7-11. Her other involvement in the Penobscot River Mercury Study was restricted to chemistry, physical behavior, and microbiology. JX 39 at 13:6-10. She authored Chapter 8 of the Phase II Report and coauthored Chapters 1, 12, and 23. JX 39 at 21:7-22.

Dr. Kelly testified that once the Study Panel became aware of the mobile sediment pool, she was "involved in a lot of the discussions of [sic] trying to understand what that might mean for recovery time and how the system was behaving." JX 39 at 19:8-12. She believes that the Mendall Marsh cores are most appropriate for calculating the half time for recovery in the system. JX 39 at 179:10-17. She explained: "the cores that are taken … are a measurement tool. And you're trying to reconstruct the history of the system using that tool. And the tool works best in places where sedimentation tends to be preserved well." *Id.* She also testified that the Study Panel is "not understanding" the mobile pool. JX 39 at 118:5-6. She believes that the Study Panel "can't explain the difference in residence time of the mobile pool" and also that "if you really wanted to do a perfect job, you would know the rate of turnover of each type of material in that mobile pool." JX 39 at 117:20-118:19.

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[21] Dr. Kelly's deposition transcript can be found at JX 39 and her CV can be found at JX 23.
[22] QA/QC means quality assurance/quality control, and involves making sure laboratories are abiding by proper standards and recovery measurements as well as ensuring that the process is transparent. JX 39 at 17:19-18:4.

Dr. A. Dianne Kopec[23]

Dr. Dianne Kopec is a research biologist. Tr. 1766:7-8. She was hired by the Study Panel to do data entry, descriptive statistics for biological data, and field work. Tr. 1764:1-18; 2023:25-2024:1. She authored Phase II Report chapters on biota sampling and food web analysis and assisted Dr. Bodaly with setting biota mercury concentration targets. Tr. 1764:19-1765:2; 2049:16-19. In the past, Dr. Kopec has worked with various environmental advocacy groups and she practiced civil disobedience while working for Greenpeace. Tr. 2024:5-2025:12. Dr. Kopec has never participated in a formal ecological risk assessment. Tr. 2025:24-2026:5. She is not an expert in human health risk assessment or exposure assessment. Tr. 2027:9-20. She is not an expert on sediment core dating. Tr. 2028:2-6. Nor is she an expert on remediation of contaminated sites or sediments. Tr. 2027:21-2028:6.

Dr. Kopec testified that there is no concern for toxic effects with respect to nineteen species of Penobscot biota. Tr. 2034:5- 2036:11. With respect to the target to protect invertivorous birds, Dr. Kopec initially felt that the Jackson paper on Carolina wrens was not a strong enough base for the target to protect bird health. Tr. 2052:18-22. Consequently, she looked for other papers assessing different endpoints. Tr. 2052:18-2053:1. Dr. Kopec testified that she would define toxicity to include some biochemical responses (Tr. 2062:1-3) and at the time of carrying out her work for the Penobscot River Mercury Study, was not familiar with the EPA's position on using biochemical or behavioral effect studies for the purpose of ecological risk assessment. Tr. 2026:6-12. She agreed that it is difficult to assign population significance to biochemical effects and sublethal effects in individuals. Tr. 2026:13-2027:4.

Dr. Kopec testified that trends in biota mercury concentrations may be different than trends found in sediments (Tr. 2031:18-20) and explained "we did not find a pattern of change in the sediment, nor did we find a pattern of change in the organisms that feed in the benthic food web." Tr. 2031:21-2032:2. She also testified that there is limited information to compare sediment and bird mercury concentrations, and noted that sediment samples taken "may not necessarily reflect the actual sediment concentrations in the marsh as a whole." Tr. 2032:3-14. The Study Panel often did not sample sediment mercury levels in the same location where it sampled the birds. Tr. 2032:15-19. With respect to Nelson's sparrow foraging patterns, Dr. Kopec testified that the food web study was not carried out as described in the proposal. Tr. 2064:15-21. She explained that "because sometimes birds were sampled before the prey was sampled, I wasn't able to look at the range of prey items that might have been available to the birds and that would be affecting their stable isotope concentrations" (Tr. 2065:4-8), which are used to estimate prey items as being part of a bird's diet. Tr. 2064:22-2065:3.

Dr. Kopec's testimony is significant because it emphasizes that more work needs to be done to understand whether there are significant adverse effects to birds in the Penobscot system.

[23] Dr. Kopec's testimony can be found at Tr. 1762:14-1825:25, 1964:7-2071:11 and her CV can be found at JX 24.

Mr. Reuben Butch Phillips[24]

Mr. Butch Phillips, a Penobscot Indian Nation elder, served as a fact witness for the Plaintiffs. He testified about the Penobscot Nation's relationship to the river. Tr. 1852:21-1854:11. He also described his observations of the river during his lifetime, including his observation that pollution in the Penobscot River peaked in the 1950s. Tr. 1856:20-24. He stated that "any improvement in any type of pollution or taking out of dams … is a great improvement." Tr. 1857:3-5. He also stated "I never thought in my lifetime that I would see the Penobscot River being cleansed and/or dams taken out so that the sea-run fish and other fish could move up the river." Tr. 1856:25-1857:2.

Mr. Phillips' testimony about the peak of pollution in the Penobscot River in the 1950s, and his statement that he never thought he would see the Penobscot River being cleansed, is legally significant with respect to the issues pending before the Court because it indicates that the system has greatly improved in one lifetime, and when coupled with other evidence at trial, suggests that the system will continue to improve. Otherwise, his testimony does not help frame for the Court issues of mercury contamination is in the Penobscot estuary, how the system is recovering, and what, if anything, can be done about it.

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[24] Mr. Phillips' testimony can be found at Tr. 1848:5-1862:10.

Dr. John Rudd[25]

Dr. John Rudd, Chair of the three-member Study Panel, is an "ecosystem scientist," Tr. 13:18-25, whose scientific focus is on biogeochemistry, the intersection between biology and chemistry. Tr. 15:24-16:16. Dr. Rudd is not a toxicologist. Tr. 33:2-4. He testified that hydrodynamics of the system is probably what he is least familiar with. Tr. 16:25-17:1. Dr. Rudd is not an expert with respect to the engineering component of remediation. Tr. 163:12-19; 266:12-14.

Dr. Rudd described the nine year, multiphase Penobscot River Mercury Study. Tr. 76:16-19. He stated that over this time "many, many thousands" of samples were collected. Tr. 76:20-24. With respect to Phase I of the study, Dr. Rudd testified that there were not "across-the-board high concentrations – in the biota." Tr. 59:24-25. With respect to sediment mercury concentrations, he stated that mercury concentrations in the system have been decreasing since 1967, and they continue to do so today. Tr. 128:6-8; 394:20-22. He explained that cleaner particles enter the mobile pool in the upper estuary and more contaminated particles in the mobile pool are "constantly sedimenting out or … escaping downstream" and this causes the system to gradually clean itself up. Tr. 128:8-16. With respect to calculating a halftime for recovery, Dr. Rudd testified that the Mendall Marsh cores are most representative and should be used. Tr. 406:10-20; 407:11-25.

Dr. Rudd agrees that if engineers go out and start trying to work before it has been determined that a certain remedial alternative is scientifically feasible, there could be significant problems. Tr. 266:15-23. He testified, based on previous experience, that wholesale dredging of a system with deeply buried contaminants is a concern. Tr. 276:10-277:13; 278:10-16. He agrees with Dr. Connolly that bank-to-bank dredging is a remedy that should not be considered going forward and noted that the Study Panel unanimously agreed not to recommend it. Tr. 281:3-11. Dr. Rudd also testified that capping isn't "the way to go" because of concerns related to methylation under the cap, and the possibility that future erosion could threaten release of high concentrations of methylmercury into the environment. Tr. 282:12-284:14. Other concerns were that capping would artificially elevate the mudflats in the estuary, making them more susceptible to erosion. *Id.* Dr. Rudd also worried that covering the marsh in five or six centimeters of clean sediment would be very disruptive to vegetation and the bird population, and would require a "tremendous" restoration effort. *Id.*

Dr. Rudd had concerns about each of the remedies that were proposed by the Study Panel in Chapter 23 of the Phase II Report. Tr. 291:17-20; 290:11-17; 306:12-18. His testimony is significant because he explained that there are "outstanding questions" that need to be addressed before engineers can design a remedy. Tr. 323:3-18. He added that "there's something we don't understand about the mobile pool yet, and … until we understand that better, we won't be able to give the … engineers precise directions of – of how they should design the removal of the mobile pool." Tr. 328:2-6.

[25] Dr. Rudd's testimony can be found at Tr. 10:17-464:3 and his CV can be found at JX 25.

Dr. Mark Sandheinrich[26]

Dr. Mark Sandheinrich testified by deposition on December 10, 2013. He is a Professor of Biology at the University of Wisconsin-La Crosse (JX 40 at 6:6-16), and has expertise on the effects of mercury on wildlife, including fish, avian fauna, and mammals. JX 40 at 10:20-11:8. He authored Appendix 2-1 to Chapter 2 of the Phase II Report, a "literature review of the effects of methylmercury on fish and wildlife." JX 40 at 13:2-21; 36:3-22. Dr. Sandheinrich did not endorse any threshold levels set by the Study Panel. JX 40 at 92:17-18. He has never been involved in mercury remediation projects or in setting targets for use in mercury remediation projects. JX 40 at 222:8-17. He has not read the Study Panel's Phase II Report, is not aware of the Study Panel's findings or recommendations (JX 40 at 126:18-127:6), and is "not aware of the extent of the contamination" or "the issues surrounding [the] Penobscot River." JX 40 at 59:18-21.

Dr. Sandheinrich testified that when he thinks about the effects of mercury on aquatic organisms, he distinguishes between fish and shellfish. JX 40 at 37:23-38:2. He explained: "I don't believe there's very much known about the effects of mercury on shellfish." JX 40 at 38:3-6. In his literature review, Dr. Sandheinrich stated that "relatively little is known of the toxicological significance to fish of environmentally relevant exposures to methylmercury." JX 6-2 at App. 2-1, 21 (internal citation omitted). He explained at his deposition that there are "multiple reasons for this," but among them is the fact that "fish are difficult to study." JX 40 at 73:5-24. Dr. Sandheinrich is familiar with the statistical method used to calculate toxic effects levels, which Dr. Keenan used, and referred to that methodology as "common practice." JX 40 at 81:14-83:6 (referring to Beckvar et al. 2005 (*see* JX 101 at 2096)).

Dr. Sandheinrich stated that scientific studies on effects of mercury on birds have primarily focused on piscivorous species and, consequently, little is known about the effects of methylmercury on invertivorous birds. JX 6-2 at App. 2-1, 2, 13; JX 40 at 53:19-54:17. He testified that to determine whether Mendall Marsh sparrows are affected by mercury, it would be possible to devise studies looking at effects of interest (reproductive effects) such as nesting success, clutch size, and the proportion of eggs that hatch and fledge. JX 40 at 42:2-23. He testified that all effects are not necessarily adverse effects. JX 40 at 65:25-66:16. He also noted that different species of birds vary in sensitivity to mercury, and different populations of the same species of birds can vary in how they are affected by mercury. JX 40 at 69:6-70:8. This is in part because effects can differ depending on ecological conditions such as the presence of other stressors in the environment. JX 40 at 44:5-45:18 (i.e., drought, predators, co-occurrence of other contaminants). Based on his literature review, Dr. Sandheinrich testified that there might be population-level effects in bird population at 3 ppm or greater. JX 40 at 24:16-25:3; 29:6-19.

Dr. Sandheinrich testified that to determine if there are effects to individual birds or bird populations at a particular location, field study is required. JX 40 at 152:2-13; 153:25-154:9. This testimony is significant because it supports the position that additional study of Mendall Marsh song birds is necessary to determine if there are individual or population level effects due to the presence of methylmercury.

[26] Dr. Sandheinrich's deposition transcript can be found at JX 40 and his CV can be found at JX 26.

Dr. Peter Santschi[27]

Dr. Peter Santschi was tasked by the Study Panel to evaluate the natural recovery time of the whole riverine system. Tr. 1682:21-1683:1. Dr. Santschi acknowledged that this is very difficult and challenging and hasn't been done many times. Tr. 1683:6-8. Recovery calculations are not an exact science and require that certain assumptions be made. Tr. 1729:16-23. There are a number of different methods for calculating recovery times. Tr. 1720:25-1721:7. Different methods can yield different recovery times, and there is no standard technique for determining recovery times. Tr. 1723:11-23.

To evaluate the recovery time of the Penobscot system, Dr. Santschi chose what he referred to as the exponential curve fit. Tr. 1724:16-18. Dr. Santschi acknowledged that the exponential curve fit was the simplest of the various approaches. Tr. 1724:19-21. He described this approach as crude and simple-minded for a system as complex as the Penobscot. Tr. 1724:22-1725:13. Dr. Santschi had never used this approach before and is not aware of a single instance in which the methodology he used to estimate the Penobscot system's natural recovery time has been used before. Tr. 1725:14-1726:2.

The exponential curve fit involved evaluating recovery half-times in sediment cores by comparing the sedimentation rate to decreases in mercury concentrations over time. Tr. 1683:9-18. In his evaluation of the cores, Dr. Santschi concluded that there was a period of rapid decline in mercury after a spike in the late 1960s, followed by a slower decline. Tr. 1687:17-1688:3. In order to calculate the recovery time based solely on the slower decline, he simply halved the forty-two year period observed—1967-2009—to look at the last twenty-one years in the cores. Tr. 1728:4-17. Dr. Santschi acknowledged that this halving was arbitrary. Tr. 1688:6-8; 1694:4; 1717:3-5. He could have just as easily chosen fifteen years or thirty years. Tr. 1694:13-24; 1717:1-9. He testified that an alternative approach could have been to evaluate each core individually to determine an appropriate period within that core to calculate recovery half-times. Tr. 1729:8-20.

Dr. Santschi testified that not every core accurately represents what's happening in the system. Tr. 1686:15-24. For example, cores showing a constant mercury profile or ones that increase over time reflect sites that are not in close communication with the rest of the system and thus are not representative of the system as a whole. Tr. 1741:23-1742:7; JX 6 at 6-14. The Mendall Marsh cores, however, were more consistent than those elsewhere and provide better, less variable profiles because Mendall Marsh is a more quiescent environment. Tr. 1743:8-1744:9. The Mendall Marsh cores, therefore, are more reliable than those from other areas in the system. Tr. 1744:10-20.

Dr. Santschi's estimate of the recovery half-time for Mendall Marsh was twenty-two years. Tr. 1710:12-15. This was the shortest half-time of any area of the system. *Id*. Dr. Connolly's estimates for Mendall Marsh were within the range of variability of Dr. Santschi's. Tr. 1733:9-15. Dr. Santschi's recovery half-time for Mendall Marsh were also more consistent with the field sampling data measuring the mobile pool. Tr. 1745:2-10.

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[27] Dr. Santschi's testimony can be found at Tr. 1680:5-1752:15 and his CV can be found at JX 27.

Mr. Jack Siegrist[28]

Mr. Jack Siegrist testified by deposition on November 11, 2013. Mr. Siegrist was a research assistant with Applied Biomathematics during the Penobscot River Mercury Study. JX 41 at 15:10-24. The Study comprised a relatively small portion of his work while he was at Applied Biomathematics. JX 41 at 20:10-17. Mr. Siegrist helped Dianne Kopec set up power analyses and also set up the code for the analysis of her data for the trends in mercury concentrations over time. JX 41 at 34:10-13. He communicated only with Dianne Kopec and no others involved with the Study. JX 41 at 59:22-25. He served as a kind of "help desk" for the Study's use of certain statistical software. JX 41 at 16:19; 109:20-24. He did not perform any analyses himself and he did not offer any opinions as to the adequacy of the statistics used. JX 41 at 49:5-6; 35:3-12; 94:4-7; 32:8-19.

Mr. Siegrist did not see any Study Panel report or any drafts thereof. JX 41 at 12:12-21; 38:2-5; 169:8-14. He did not provide any direct input on any reports. JX 41 at 13:7-18. He did not offer any opinions to Dr. Kopec or others regarding the project or the quality of their statistics; nor did he review the statistics used by the Study Panel or included in their report. JX 41 at 28:24-29:15; 43:23-25.

[28] Mr. Siegrist's deposition transcript can be found at JX 41 and his CV can be found at JX 28.

Dr. Ralph Turner[29]

Dr. Ralph Turner testified by deposition on October 3 & 4, 2013 and March 12, 2014. Dr. Turner is a geochemist who has spent most of his career working on mercury in the environment. DX 955 at 10:2-16. He was asked by the Study Panel to develop an estimate of current mercury loadings from the HoltraChem plant and from other sources. DX 955 at 21:8-17. His sampling of loading from HoltraChem included a large storm event that significantly increased his loading calculation. DX 955 at 26:9-20; 28:12-16. He, nevertheless, concluded that HoltraChem is not a significant ongoing source of mercury to the system. DX 955 at 35:19-22.

In evaluating other ongoing sources of mercury to the system, Dr. Turner did not look at all of the tributaries loading to the Penobscot. DX at 48:17-49:2-5. For example, he did not look at point source discharges into the Orland River or from tributaries into the Orland River. DX 955 at 74:17-75:1. Measurements of loading over the Veazie Dam were also limited. DX 978 at 39:3-20. His team did not sample tributaries or loading over the Veazie Dam during high flow events. DX 955 at 49:25-50:13; DX 978 at 40:11-41:3. Dr. Turner testified that there was simply not enough sampling to determine the average long-term total loading to the river from Veazie Dam and other tributaries. DX 978 at 44:20-45:15.

Dr. Turner was not specifically tasked with examining historical sources of mercury to the Penobscot River. DX 955 at 17:3-6; 22:2-19. And any effort to do so was not "particularly diligent." DX 955 at 266:15-22. Dr. Turner testified that his quantification of the amount of historical mercury loading from the HoltraChem plant was just a "best guess." DX 955: 64:25-65:11. He used data related to chlor-alkali facilities generally, rather than site-specific data, to make his estimate. DX 978 at 18:16-25. To account for the uncertainty, he simply doubled his estimate of mercury loading from HoltraChem to derive a range of 6-12 tons. DX 955 at 66:8-67:2. His estimate assumed that HoltraChem operated during the entire year in 1967, even though it did not begin operation until December 1967. DX 955 at 69:24-70:1. He acknowledged that he "could have done a better job" estimating historical loading of mercury from HoltraChem. DX 978 at 67:16-69:18.

Dr. Turner's estimates of mercury loading from other sources were similarly limited. He understands that pulp and paper mills on the Penobscot used mercury fungicides in their operations, but he did not investigate which mills used fungicides or how much they used. DX 955 at 165:10-22. He did not do any analysis of the historical mercury loading to the Penobscot estuary coming over the Veazie Dam. DX 955 at 183:6-17. It remains uncertain how much mercury that remains trapped in the system came from the HoltraChem facility versus other sources. DX 978:41:11-42:14.

[29] Dr. Turner's deposition transcripts can be found at DX 955, 956 & 978 and his CV can be found at JX 29.

Dr. Dimitrios Vlassopoulos[30]

Dr. Dimitri Vlassopoulos is an expert in environmental geochemistry and contaminant hydrology and a principal scientist with Anchor QEA. Tr. 2961:21-23; 2962:20-21. He has worked on contaminated sites since 1992 and, since 2000, has worked on dozens of contaminated sediment sites. Tr. 2963:17-25. Dr. Vlassopoulos spends about three quarters of his professional time evaluating site-specific remedial work. Tr. 2964:20-22. He has worked for clients of all sorts, including federal government agencies. Tr. 2964:12-19. Here, Dr. Vlassopoulos evaluated the methylation processes occurring within the Penobscot, the extent to which the geochemical properties of the system impact methylation, and the impact of those conditions on potential in-situ remediation options. Tr. 2965:3-9.

Dr. Vlassopoulos explained that a number of factors affect the mercury methylation process. Tr. 2968:20-2970:7. Using the same data Dr. Gilmour relied upon, Dr. Vlassopoulos concluded that total mercury concentration is a poor predictor of methylmercury concentrations in Mendall Marsh. Tr. 2981:8-2982:10; 2985:4-10. He showed, for example, that many individual samples contained high total mercury and low methylmercury concentrations and vice versa. Tr. 2984:8-2985:16. Dr. Vlassopoulos also demonstrated, using correlation coefficient (R), that there is a statistically significant relationship between total mercury and methylmercury but that for predictive purposes, the coefficient of determination (R^2) shows that total mercury explains only 11 percent of the variability in methylmercury. Tr. 2987:9-2988:4. The variability is more fully explained by the conditions and processes that create methylmercury, such as porewater chemistry and sediment-porewater partitioning (K_d). Tr. 2969:2-2970:3; 2977; 3008:3-3009:18.

Dr. Vlassopoulos explained that Dr. Gilmour's statistical models for methylmercury in Penobscot sediments and solids did not change his opinion regarding total mercury's predictive power. Tr. 2986:7-2990:16. The models did not focus on total mercury, omitted factors affecting the methylation process, contained a high degree of predictive uncertainty, and used a logarithmic transformation that exaggerated the association between total mercury and methylmercury. Tr. 2990:5-3000:25. Even accepting Dr. Gilmour's model, major reductions in total mercury might not create any meaningful reduction in methylmercury. Tr. 3001:8-3002:23. Because of the lack of predictive power, Dr. Vlassopoulos concluded that no target for total mercury hotpot removal would reliably result in a meaningful methylmercury reduction across Mendall Marsh. Tr. 3002:18-23; 3013:4-19; 3037:3-6.

Dr. Vlassopoulos also reviewed the Study Panel's plot study of in-situ amendments. Tr. 3013:20-22. Dr. Vlassopoulos testified that the key parameters for evaluating whether an in-situ remedy will be effective are the magnitude of the effect and the duration of the effect. Tr. 3019:24-3020:20. None of the amendments was effective at reducing total mercury or methylmercury two years after the amendments were applied. Tr. 3018:1-25; 3021:13-3024:1. Dr. Vlassopoulos testified that Dr. Gilmour ignored the diminishing effectiveness of the amendments over time. Tr. 3024:2-22. Dr. Vlassopoulos further created a model showing that the magnitude of activated carbon's effectiveness levels off and is effectively capped as more activated carbon is added. Tr. 3025:1-3029:16.

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[30] Dr. Vlassopoulos' testimony can be found at Tr. 2961:7-3062:14. Dr. Vlassopoulos' expert report and CV can be found at JX 59.

Dr. Vlassopoulos identified factors that could limit the duration of activated carbon's effectiveness in Mendall Marsh, including mercury fluxes into the treatment zones and organic matter fouling the surface of the carbon. Tr. 3032:17-3033:8. Because of activated carbon's limited longevity, activated carbon would have to be repeatedly applied, and in a relatively short period of time the marsh would be predominantly comprised of carbon, rather than sediment. Tr. 3030:13-3034:7. Dr. Vlassopoulos concluded that none of the amendments tested in the Penobscot study represent feasible options for in-situ remediation in Mendall Marsh. Tr. 3037:3-23.

Dr. Christopher Whipple[31]

Dr. Chris Whipple is a member of the court-appointed Study Panel. Tr. 464:23-24. His educational background is in engineering and he currently works for Environ, a general-purpose environmental consulting company. Tr. 465:2-19. Environ subcontracted almost all of the scientists retained by the Study Panel and Dr. Whipple supervised that effort. Tr. 471:21-472:15. His expertise is in human health risk analysis and risk management. Tr. 466:20-25. He does not have a great amount of expertise in ecological risk assessment. Tr. 473:15-19.

Dr. Whipple testified that mercury levels in several species of Penobscot biota that are consumed by the public do not pose an unacceptable risk to human health. Tr. 599:20-600:14. With respect to the remaining species, he testified that "we don't have information on consumption rates of Penobscot-specific items, and therefore can't conclude the extent of the public health problem." Tr. 616:2-4; 623:25-624:7. He testified that there is not a great population exposure or health risk caused by consumption of Penobscot black ducks and eels. Tr. 601:5-8; 609:7-9; 610:7-13; 606:1-4. With respect to Penobscot area lobster, Dr. Whipple testified that it is unknown where they end up in the market place and agreed that the latest data show that concentrations are below the Maine state action level in all but one location, and are declining at that location. Tr. 597:15-17; 599:8-19. He stated that Dr. Grandjean's opinion that food items with levels of methylmercury measured in the Penobscot should not be eaten by consumers was "a bit too strong" and "overstates the evidence." Tr. 614:19-24; 615:20-616:4. Dr. Whipple testified that "he wouldn't argue too much" with the statement that a single meal is unlikely to be risky to the health of someone eating it. Tr. 617:3-7. With respect to ecological risk, Dr. Whipple testified that the Study Panel has not observed actual harm to biota in the Penobscot. Tr. 624:20-22.

Dr. Whipple stated that the Penobscot is "a very complicated system, and many of the factors we looked at are uncertain to within a factor of two." Tr. 645:1-12; 654:10-14. He explained that "there is not … a one-size-fits-all solution that has been applied at contaminated sites." Tr. 647:8-16. He agreed that if remediation options would make things worse in the system, living with longer recovery times would be preferable. Tr. 644:9-15. Regarding the remedial options presented by the Study Panel, Dr. Whipple characterized them as the ones that weren't obvious bad ideas and testified about problems with the remedial alternatives that were contemplated. Tr. 648:7-23; 649:24-650:2; 650:17-21; 655:11-20; 659:22-660:20.

Dr. Whipple also testified that he agrees with a statement he included in an earlier draft of Chapter 22: "we have not attempted to assign a cost to the environmental harm in the system from mercury. Given that no endangered species are apparently threatened, that human exposures are likely little different than those that are experienced elsewhere in Maine, and that affected species have been through the worst, it is difficult to justify extremely large expenditures." Tr. 663:20-664:1; 664:2-665:7. His testimony is significant because it demonstrates that in light of the lack of evidence of a human health risk in the Penobscot, the complexity of the system, and the nonexistence of an obvious remedy, there is no basis for moving forward with immediate consideration of remedial alternatives.

[31] Dr. Whipple's testimony can be found at Tr. 464:5-676:2 and his CV can be found at JX 30.

Dr. James Wiener[32]

Dr. James Wiener is a professor at the University of Wisconsin, La Crosse. Tr. 1407:25-1408:5. His educational background is in zoology. Tr. 1409:2-5. Dr. Wiener commented on the Penobscot River Mercury Study design and was hired to conduct a peer review of the Phase II Report. Tr. 1412:15-1413:1; 1415:22-1416:6; 1494:13-18. Dr. Wiener's primary focus in his career has been on freshwater bodies. Tr. 1493:2-4. He is not an engineer by training or profession. Tr. 1493:5-7. Dr. Wiener's work with sediment has not involved making "inferences or estimates on future patterns or recovery." Tr. 1493:24-1494:7. Dr. Wiener testified that he is "not a sediment-transport person" or a hydrodynamicist. Tr. 1494:8-12. Dr. Wiener could not assess whether remedial alternatives presented in the Phase II Report were likely to be feasible or effective. Tr. 1503:23-1504:2. He stated that he would defer to Dr. Evers regarding birds. Tr. 1507:9-11. Despite these gaps in his specific areas of expertise, Dr. Wiener commented on the majority of the chapters in the Phase II Report. He, for the most part, did not have any substantive comments or criticisms. Tr. 1495:4-1496:7.

Dr. Wiener testified that he has "not seen information, one way or the other, to indicate to what extent humans are consuming organisms – food items produced in the river and in the estuary." Tr. 1493:8-13. He also testified that "dredging of sediments along the extent of the contaminated river, main stem and the marshes and the lower estuary" is probably not a logistically feasible approach. Tr. 1499:25-1500:5. He also stated that it "seems apparent" that remediating widely disbursed sediment would be a logistically herculean task. Tr. 1500:6-9. When discussing fish toxicity, Dr. Wiener often referred to biochemical effects. *See, e.g.*, Tr. 1515:7-20. Regarding the Depew paper, which Dr. Wiener co-authored, JX 76, and which served as the basis for the Study Panel's target to protect fish predators, Dr. Wiener testified: "what we did with this study is we did the best we could with the information available. There have been very few reproductive effect studies." Tr. 1538:4-17. He testified that certain endpoints are difficult to relate to population level impacts, and "we have a hard time saying what the relevance of those behavioral effects might be." Tr. 1542:4-20. He explained that there are a "limited number of high-quality studies…. This is a very new area of investigation… [W]e need more studies to … nail things down more firmly." Tr. 1529:17-1530:2. Nevertheless, the Study Panel's proposed threshold is the lowest value that Dr. Wiener reported in his book chapter. JX 77; Tr. 1516:12-19.

Dr. Wiener's testimony establishes that the extent of harm in the Penobscot is not well quantified at this time, and accordingly, it is not appropriate to begin evaluating remedial alternatives.

[32] Dr. Wiener's testimony can be found at Tr. 1406:20-1560:10 and his CV can be found at JX 31.

Mr. Kenneth Wyman[33]

Mr. Ken Wyman, a commercial lobster fisherman, served as a fact witness for the Plaintiffs. Tr. 1830:17-18. Mr. Wyman set 115-150 out of his 800 traps in the portion of the river that is now subject to DMR's fishery closure. Tr. 1833:22-1835:3. He placed traps in that portion of the river because it was productive to do so and made economic sense. Tr.1841:24-1842:13. Mr. Wyman testified that he fished lobster around the southern and eastern edge of Verona Island, Odom Ledge, and at Fort Point in mid-July through the first of November. Tr. 1831:11-1833:21. He testified that it is possible to relocate these 150 traps. Tr. 1841:21-23. Mr. Wyman's seafood business operated seven days per week from mid-May to Christmas. Tr. 1837:9-11.

Mr. Wyman is not familiar with lobster mercury concentrations in the closed area compared with lobster mercury concentrations outside of the closed area. Tr. 1846:2-5. He testified that other portions of the river have been closed to shell fishing for some time. Tr. 1847:3-6.

Mr. Wyman's testimony is not scientifically or legally significant with respect to the issues pending before the Court. His testimony does not help frame for the Court issues of mercury contamination in the Penobscot estuary, how the system is recovering, and what, if anything, can be done about it.

[33] Mr. Wyman's testimony can be found at Tr. 1829:13-1848:3.

Dr. Kevin Yeager[34]

Dr. Kevin Yeager was tasked with developing and implementing a field program for the collection of long sediment cores. Tr. 1279:2-1280:3. He prepared Chapter 5 of the Phase II Report, which derived sediment accumulation rates from the sediment cores, quantified the inventory of mercury held in the upper 90 centimeters of the cores, and reported the contemporary fluxes of total mercury to surface environments. Tr. 1280:4-1282:22.

Dr. Yeager's team took three sediment cores at each of 72 stations throughout the system. Tr. 1291:24-1292:7. They selected certain cores based on their judgment that the cores indicated a stable environment of sediment accumulation. Tr. 1293:11-18. The team ended up with one core from each of 58 locations. Tr. 1297:1-24. Those 58 cores were sent to labs for full radiochemical analysis. Tr. 1299:3-6. As a whole, Dr. Yeager thought the Mendall Marsh cores provided the highest fidelity record of historical processes in the system. Tr. 1394:1-11.

Dr. Yeager used radionuclide analyses of the cores and assumptions about the date of peak mercury releases to estimate the sediment accumulation rate. Tr. 1282:24-1283:13; 1366:9-1368:19. In addition, he began with the assumption that peak mercury concentrations in cores were a chronological marker for 1967. Tr. 1283:9-13; 1323:10-13; 1368:20-1369:2. Dr. Yeager later agreed with the critique from Mallinckrodt's expert Gary Bigham that he should not have started out assuming that mercury peaks in the cores marked the year 1967. Tr. 1349:14-18; 1376:10-24.

There were numerous uncertainties in Dr. Yeager's sediment accumulation rate calculation. For example, the resolution of the core analysis was not very high. Tr. 1369:3-20. Moreover, each of the radionuclides used had limitations. Tr. 1318:1-1321:18. The high energy of the system, for example, could alter sedimentation rates and upset the chronological markers for the radionuclides. Tr. 1320:4-1321:18. The uncertainties are reflected in cores where mercury and cesium peaks were inconsistent with the dates they were assumed to mark. Tr. 1370:3-1375:18. Finally, there was uncertainty introduced by Dr. Yeager's unawareness of the former Bangor Dam. Tr. 1349:19-21; 1352:5-25; 1376:4-1377:9. These uncertainties applied to every core that was taken. Tr. 1377:7-9.

Dr. Yeager testified that he found Dr. Santschi's recovery half-time estimates reasonable. Tr. 1343:12-24. But, when questioned, he did not properly recall the half-times Dr. Santschi had estimated. Tr. 1343:23-1344:11. Dr. Yeager testified that there are various approaches to calculating recovery half-times, each of which can result in a different half-time. Tr. 1378:12-14; 1384:3-1387:6.

Dr. Yeager's mercury inventory extrapolated concentrations in the cores to the entire system. Tr. 1305:4-25; 1388:23-1389:13. He acknowledged that to extrapolate core concentrations over the entire system would grossly overestimate total mercury because there are many areas in the system where sediments—and thus mercury—do not accumulate. Tr. 1305:13-18. He relied on indirect lines of evidence to estimate the non-depositional areas of the system. Tr. 1306:1-1307:20. Study scientists then contoured the distribution of mercury inventories through a

[34] Dr. Yeager's testimony can be found at Tr. 1272:7-1406:18 and his CV can be found at JX 32.

process called kriging. Tr. 1307:24-1311:24. Dr. Yeager is not an expert in kriging. Tr. 1388:13-15. He acknowledged that there was a fair amount of uncertainty in his mercury inventory calculation. Tr. 1312:13-16. He testified that his mercury inventory included mercury that entered the system before the HoltraChem facility was operational, and he would want to redo his analysis if he were to determine the mercury inventory associated with releases from HoltraChem. Tr. 1313:22-1314:20.