BEFORE THE MAINE BOARD OF ENVIRONMENTAL PROTECTION

Verso (formerly International Paper Company), Jay, ME0001937 and W000623–5N–F–R	))))	ANDROSCOGGIN RIVER APPEALS

DIRECT TESTIMONY OF JOHN LICHTER

(Note: All of Dr. Lichter's testimony is applicable to both the general discussion on the TMDL and to the specific appeal of the Verso permit)

My name is John Lichter. I am an Assistant Professor of Biology and Environmental Studies at Bowdoin College in Brunswick, Maine. I have been asked by the Natural Resources Council of Maine ("NRCM") to provide testimony on the appropriate phosphorus limits and compliance schedule for Verso's pulp and paper mill in Jay, Maine (the "Jay mill"). Based on my background and experience, and on my research into eutrophication in Merrymeeting Bay, it is my opinion that the phosphorus limits and timeline for compliance in the Jay mill's current waste discharge license are likely inadequate to protect the Androscoggin River and Merrymeeting Bay from algal blooms and other deleterious effects of phosphorus pollution in those waterways. Ongoing phosphorus inputs and possibly recycling of phosphorus discharged in the past have almost certainly stalled the ecological recovery of Merrymeeting Bay.

EXECUTIVE SUMMARY

Pulp and paper mills on the Androscoggin River have heavily polluted it with phosphorus. There is a lot of evidence of phosphorus pollution in the Androscoggin River system. In its 2002 Modeling Report on the River, the Maine Department of Environmental Protection ("DEP") stated that widespread algae blooms occurred every summer in Gulf Island Pond. I discuss this modeling report, along with photographs of these blooms, later in this testimony.

In addition, Merrymeeting Bay, a focus area of my research and into which the Androscoggin River flows, is heavily polluted with phosphorus. I know this from evidence obtained from the sediments in the bottom of the river and from laboratory experiments I have performed on algae growth in water from the Bay. I will discuss this evidence in detail in this testimony. The phosphorus pollution in the Bay and the resulting heavy growth of algae is preventing the Bay from recovering to its full potential as a spawning and nursery area for sea–run fish, such as striped bass, Atlantic salmon, and river herring. The Bay was an excellent spawning and nursery area prior to being highly damaged by industrial pollution.

It is my strong belief that phosphorus levels from the Jay mill must be reduced as much as possible to help Merrymeeting Bay recover and that these reductions should take place as soon as possible. The reductions that have taken place since 2004 appear already to have had a beneficial effect on the River because the DEP did not observe any widespread algae blooms in Gulf Island Pond in 2005 and 2006. At the very least, the Board should require immediate compliance with the September 2005 permit limits (not compliance in ten years as the permit would allow) and should consider even stricter limits, because the Jay mill has demonstrated it can meet them and because it will likely require stricter limits to allow the Bay to start to recover its full potential as a resource for the people of Maine.

BACKGROUND AND EXPERIENCE

I received my Ph.D. in Ecology from the University of Minnesota's Department of Ecology, Evolution, and Behavioral Biology in 1995. From 1996–2000, I served as a research associate and instructor at Duke University in the Department of Botany. From

2000 to the present, I have been an Assistant Professor in the Biology and Environmental Studies Department at Bowdoin College. In July of this year Bowdoin College will promote me to Associate Professor with tenure. A copy of my current professional *curriculum vitae* is attached as NRCM Exhibit 16 to my testimony.

My research interests include the study of coastal eutrophication, a process generally caused by pollution, through which water bodies become so enriched by nutrients, such as phosphorus, that algal blooms occur, causing serious harm to those water bodies and the ecosystems they support. Recently, my colleagues in the Environmental Studies Program at Bowdoin and I received a $365,000 grant from the Henry Luce Foundation to study the ecology and environmental history of the Merrymeeting Bay/Kennebec estuary ecosystem. To date, the results of our research have been published in two peer reviewed scientific journals, *Ecological Applications* and the *Northeastern Naturalist*. *Ecological Applications* is a widely read, first–tier scientific journal, and the *Northeastern Naturalist* is a well–respected, but regional, natural history journal with a narrower readership.

In brief, our investigations of eutrophication in Merrymeeting Bay indicate that this unusual freshwater tidal ecosystem continues to suffer from an overload of nutrient pollution, especially phosphorus, which threatens to stall its recovery. The maintenance of current levels of phosphorus in the ecosystem — and certainly any increase in those levels — would have a direct deleterious effect on the Bay and its aquatic life. Furthermore, the Jay mill's phosphorus discharges have been below the level that is required by its license to be reached in 2015. Evidence suggests that the phosphorus reductions the Jay mill has made to date may have prevented algal blooms in Gulf Island

Pond. Consequently, there is no reason to allow them ten additional years to comply with a limit they can already meet, which may already be having a positive impact. In addition, these reductions will help lessen the impacts of nutrient pollution downriver in the Merrymeeting Bay ecosystem. Stimulating the ecological recovery of Merrymeeting Bay is another reason to require compliance with phosphorus limits now rather than ten years from now.

ALGAL BLOOMS ON THE ANDROSCOGGIN

One of the most obvious effects of excessive nutrient pollution are summer algal blooms — outbreaks of bright green algae that generally occur in freshwater ecosystems in response to high concentrations of phosphorus in the water. The effect of algal blooms on the Androscoggin River can be readily seen in the photographs attached as Exhibit 17 and 18. The first, by photographer Charles Feil, was taken in 1995. The second was taken in 2004 by the DEP. The thick algal mats visible in these pictures render the river unswimmable. Swimmability is one of the water quality standards required of all rivers in Maine, including the Androscoggin.

In its 2002 modeling report on the Androscoggin River, the DEP reported that algal blooms were occurring every year in Gulf Island Pond. In its 2006 report to the Legislature on Gulf Island Pond, the DEP stated it observed no widespread blooms in the summer of 2005. According to a recent report by Acheron, a consultant to the mills, no widespread algae blooms were observed in the summer of 2006, and this was confirmed with DEP biologist Barry Mower (Reports are attached as NRCM Exhibits 4, 8, and 19).

Also notable is that in 2005 and 2006, according to data from the DEP, the Jay mill’s discharge levels of phosphorus were well below the 2015 limits required in the

September 2005 permit. See NRCM Exhibit 20. The permit, as currently written, requires the Jay mill to meet a limit of 130 pounds of total phosphorus per day (measured as a monthly average). In 2005, the Jay mill's phosphorus discharges were below these limits by at least 17%, whereas in 2006, the Jay mill lowered its discharges to 29% below the 2015 limit. Similarly, the phosphorus discharges at the Rumford Paper Company mill (the "Rumford mill") were significantly below limits required in 2008, which is illustrated by NRCM Exhibit 21. Therefore, there has been a significant decrease in phosphorus load to the river over the past two years.

The correlation between the reduced phosphorus discharges in 2005 and 2006 and the absence of widespread algal blooms is both evident and suggestive. Although observations over two summers — especially wet summers like those of 2005 and 2006 — does not demonstrate conclusively that the phosphorus reductions achieved to date are sufficient to prevent algal blooms in Gulf Island Pond, the fact that the algal blooms did not occur in the years of reduced phosphorus discharge is a very good sign that such was the case. Under the circumstances — circumstances in which the Jay mill has successfully reduced its phosphorus discharges below the limits set for 2015 and this reduction has been correlated with an absence of summer algal blooms — it makes no sense to allow the Jay mill ten more years to comply with limits it has already met two summers in a row.

PHOSPHORUS HARMS AQUATIC ECOSYSTEMS

Another reason to reduce phosphorus discharges to levels as low as possible — and not allow a ten–year phosphorus compliance schedule — is the phosphorus problem in Merrymeeting Bay. The Bay is a vitally important ecosystem in the State. It is an expansive freshwater tidal ecosystem that historically provided crucial spawning and nursery habitat for anadromous fish (*i.e.*, fish that live in the ocean but enter rivers to reproduce, such as Atlantic salmon) and abundant forage for migrating waterfowl. Submerged aquatic vegetation once supported the base of the food web and provided important habitat. These plants differ from Merrymeeting Bay's more famous wild rice beds that inhabit the intertidal areas in that they are rooted in areas below the low tide. Their importance lies in the fact that at low tide, submerged vegetation provides the only refuge for juvenile anadromous fish such as shad, alewife, and striped bass from fish and avian predators. Submerged vegetation also provides critical habitat for the many invertebrate species that are eaten by fish and waterfowl.

There is a voluminous scientific literature describing the effects of phosphorus additions to freshwater ecosystems. Phosphorus generally limits algal growth in rivers and lakes, whereas nitrogen generally limits algal growth in marine ecosystems. This means that in freshwater ecosystems, algal blooms develop primarily in response to phosphorus pollution, whereas in saltwater algal blooms develop primarily in response to nitrogen pollution. Other variables can be important however. For example, the residence time of water in the ecosystem is pivotal. If the water moves through the ecosystem too quickly, then algae do not have enough time to proliferate even if sufficient nutrients are present.

The reason for the difference in nutrient limitation between fresh and saltwater ecosystems relates to the chemistry of phosphorus. In freshwater, iron and aluminum ions combine with orthophosphate making it unavailable for algal uptake. However, the vast quantity of ions dissolved in seawater interferes with the binding of iron or aluminum to orthophosphate, thus leaving more available for algal uptake. One would therefore expect that phosphorus would be the limiting nutrient in both the Androscoggin River and Merrymeeting Bay and that adding phosphorus would lead to algal blooms in areas where the flow rates are slow.

The proliferation of algae during a bloom decreases the clarity of river water, which attenuates the penetration of light into the water column and can reduce the abundance of rooted aquatic plants. In addition, the prodigious turnover or death of algae during a bloom can result in oxygen depletion as bacteria decompose the dead algae consuming oxygen dissolved in the river water in the process. As oxygen levels drop, fish and invertebrates die. Dead fish are an obvious indication that something is wrong. However, the shift to a different group of algal species and decreased water clarity bring more subtle, but still deleterious, changes to the ecosystem. Often the algal species that proliferate during an algal bloom are unpalatable to grazers such as zooplankton, which constitute an important link in the food web (essentially, zooplankton and insect larvae are what small fish eat). Low water clarity also adversely affects the food web. With high concentrations of algal biomass and low light penetration of the water column, the ability of submerged aquatic plants to capture enough light for photosynthesis is diminished. The loss of submerged aquatic vegetation (*i.e.*, aquatic plants rooted below the low tide line) impoverishes the food web that supports both fish and waterfowl. This process is currently of grave concern in Chesapeake Bay and many other places around the world. Once again, there is a substantial scientific literature examining the consequences of the loss of submerged aquatic vegetation in lakes, rivers, estuaries, and nearshore marine habitats.

In order to begin a long–term study of the ecology of Merrymeeting Bay, I started to research the environmental history of the Androscoggin and Kennebec Rivers. The DEP, Department of Marine Resources, and Department of Inland Fisheries & Wildlife provided a great deal of scientific information, while published histories of local towns provided the socioeconomic context. To obtain additional quantitative data from which the environmental history of the Merrymeeting Bay ecosystem could be understood, I hired a postdoctoral researcher, Dörte Köster, who specializes in diatom ecology, to help me examine the sediments of Merrymeeting Bay. Diatoms are single–celled algal species that build a silica shell around their cell wall. When an individual diatom dies, its shell falls to the bottom and is preserved in the sediments like a grain of sand. By coring into the sediments and dissecting the cores into small sections that can be dated with radiometric techniques, Dr. Köster and I reconstructed a history of eutrophication in Merrymeeting Bay.

Our results showed a natural baseline prior to European settlement in the late 17th century that was characterized by conditions of high water clarity and low phosphorus availability. Colonial land clearance was indicated by an increase in diatom number, which was followed by two centuries of severe eutrophication culminating in the collapse of the Androscoggin, Kennebec, and Merrymeeting Bay ecosystems in the mid–20th century in response to unregulated industrial and municipal pollution. It is interesting that the diatom indicators of eutrophication did not obviously reverse after the Clean Water Act of 1972 was implemented. We still see the diatom abundance and species composition that characterized the worst decades of water pollution. The reason we do not see a clear recovery in the diatom record is that high levels of nutrients, principally phosphorus, are still brought into Merrymeeting Bay from its tributary rivers.

To better understand this history of eutrophication in Merrymeeting Bay, my students and I measured nitrogen, phosphorus, carbon, and silica concentrations throughout the ice–free seasons of 2004 and 2005. Our data show that the waters of Merrymeeting Bay are awash in phosphorus relative to nitrogen. Limnologists (*i.e.*, scientists specializing in lake and river ecology) have used the ratio of inorganic nitrogen to orthophosphate to get an idea of which nutrient limits algal growth. When nitrogen and phosphorus are equally limiting to algal productivity the N/P ratio is approximately 16. In Merrymeeting Bay, the overall average nitrogen to phosphorus ratio that we observed was 8.77 ($\pm$ 1.10 SE). See NRCM Exhibit 22.

This low ratio means there is a lot of phosphorus relative to nitrogen. To further understand nutrient limitation of algal growth in Merrymeeting Bay, we conducted a small, preliminary fertilization study with water from Merrymeeting Bay in the greenhouse at Bowdoin College. This experiment showed that nitrogen rather than phosphorus elicited an algal growth response. See NRCM Exhibit 23. However, when nitrogen and phosphorus were both added, algae responded with the most prolific growth. This result indicates an overabundance of phosphorus in the water.

Given that phosphorus generally limits algal growth in freshwater ecosystems, the predominance of nitrogen limitation of algal growth rather than phosphorus limitation indicates the waters of Merrymeeting Bay are so loaded with phosphorus that the natural tendency for phosphorus to be bound with iron and aluminum is overwhelmed. The capacity of algae to use additional phosphorus is also overwhelmed without additional nitrogen. This result is consistent with our measurements of the ratio of nitrogen to phosphorus concentrations in Merrymeeting Bay waters. Both indicate that phosphorus is overabundant in the ecosystem. These results are worth emphasizing because they are so unusual. There is simply so much phosphorous in Merrymeeting Bay that nitrogen has become the limiting nutrient *despite* the natural tendency for phosphorous to limit algal growth in freshwater ecosystems.

Although we do not observe frequent algal blooms in Merrymeeting Bay — because the dynamic movement of water in the ecosystem does not allow enough time for algae to proliferate before being washed down the lower Kennebec — there are still adverse effects of reduced water clarity on the submerged vegetation of Merrymeeting Bay. The submerged vegetation occupies only a small fraction of the available habitat and where it does occur is only in extremely shallow waters where light would be more likely to penetrate to the bottom. Of several locations in Merrymeeting Bay where we surveyed submerged vegetation, we have yet to find aquatic plants deeper than 1 meter below the low tide line. The dominant species is water celery (*Vallisneria americana*). Historically, this species occurred at depths down to 7 meters in clear–water lakes. In the Hudson River, it occurs at depths of 2 meters today, suggesting that the Hudson River is in better shape than Merrymeeting Bay in terms of water clarity.

CONCLUSION

It is my opinion it is critical to discharge less phosphorus into the Androscoggin River in order to clean up Merrymeeting Bay. My research, and that of my students and colleagues, indicates that the Merrymeeting Bay ecosystem has not recovered fully from the era of unregulated industrial and municipal water pollution. It is likely that ongoing inputs of phosphorus hinder the full recovery of clear water in Merrymeeting Bay that is needed by many of the species inhabiting the ecosystem. However, requiring the mandated reduction in upriver phosphorus discharges promptly would in all likelihood help stimulate the recovery of the original algae community and the submerged aquatic vegetation that once supported the base of the food web in Merrymeeting Bay.