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Economic Benefits Associated with Reductions of Entrainment and Impingement Losses in Cooling Water Intake Structures and Implications for Oyster Creek Generating Station

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Summary

This memorandum summarizes quantitative evidence of large economic use and nonuse benefits associated with reductions in impingement and entrainment (I&E) losses of fish, shellfish, and other aquatic organisms in cooling water intake structures (CWIS). The ecological and economic effects of I&E losses and similar changes to aquatic ecosystems have been studied extensively. All evidence indicates that economic benefits from I&E reductions are significant. A substantial proportion of these benefits are non-market economic benefits that are (1) unrelated to the direct use of affected species in markets, and (2) only measurable using non-market valuation methods capable of estimating both use and nonuse values. As a result, reliance on market data alone to estimate benefits of I&E reductions will lead to gross underestimates of total benefits.

Although the likelihood of substantial economic market and non-market benefits from I&E reductions has been well-established, the empirical magnitude of these benefits can be subject to uncertainty, and there are many categories of benefits that have not been adequately captured in past cost-benefit analyses (CBA) of policies that require changes in CWIS to reduce I&E losses. As a result, past analyses have likely understated actual economic benefits. Moreover, there has been no appropriate analysis of the full range of economic market and non-market benefits likely to result from I&E reductions at the Oyster Creek Generating Station. Given an absence of comprehensive and valid estimates of total economic benefits from I&E reductions at Oyster Creek, including nonuse benefits, any attempt to compare benefits and costs will provide partial and likely misleading results.

Background

Changes in cooling water intake structure (CWIS) design or operations can significantly reduce impingement and entrainment (I&E) losses of fish, shellfish, and other aquatic organisms (US EPA 2004a). Reductions in associated mortality can increase the number of organisms present in affected aquatic ecosystems, increase local and regional fishery populations, and ultimately contribute to the enhanced environmental functioning of affected aquatic (rivers, lakes, estuaries, and oceans) and linked terrestrial ecosystems. Ecological effects can be particularly pronounced in regions that are in close proximity to CWIS. From an economic perspective, affected ecological resources represent productive natural assets that provide a wide range of valuable ecosystem services to the public. These ecosystem services are defined as the outputs of natural systems that influence human welfare, or provide benefits to society (Millennium Ecosystem Assessment 2005).

Ecosystem services directly and indirectly associated with affected aquatic organisms such as fish and shellfish have been repeatedly shown to provide large and measurable market and non-market economic benefits to a wide range of user and nonuser groups (Cameron and Huppert 1989; Hanley et al. 2006; Johnston et al. 2002a,b, 2005a,b, 2006, 2009, 2010; Loomis 1996; Olsen et al. 1991; Morrison and Bennett 2004; US EPA 2004a,b, 2009). These benefits are often (though not always) measured through individual or household willingness to pay (WTP) for associated improvements in affected ecological resources, including fish and shellfish. Other quantifiable benefits are related to effects on markets, such as benefits to commercial fisheries that are adversely impacted by I&E (US EPA 2004b). This memorandum summarizes the literature and quantitative evidence providing insight on the types and magnitudes of economic use and nonuse benefits associated with reductions in I&E losses in CWIS. Of particular emphasis is the fact that a substantial proportion of these benefits are likely to be non-market economic benefits that are (1) unrelated to the direct use of affected species in markets (e.g., commercial fishing), and (2) only measurable using non-market valuation methods capable of estimating both use and nonuse values (cf. Freeman 2003).

As noted in a recent memorandum by the National Oceanic and Atmospheric Administration (National Marine Fisheries Service 2006a), the supplemental environment impact statement (SEIS) prepared by the US Nuclear Regulatory Commission (NRC) for the Oyster Creek license renewal identifies thirteen federally managed species likely to be substantially and adversely affected by I&E impacts and related thermal discharges in once-through cooling. Directly affected species include but are not limited to bay anchovy, Atlantic menhaden, blue crab, sand shrimp, Atlantic silverside, and winter flounder. Nonmarket economic benefits related to I&E reductions for these and similar species may include both use and nonuse values (US EPA 2004b, 2005), and comprehensive cost-benefit analysis requires estimates of both types of value (Freeman 2003). Past economic research has shown that use and nonuse economic benefits can be associated with reductions in I&E impacts on both species with direct human use and forage fish that do not have direct uses, but nonetheless support aquatic food webs and related ecosystem functions that directly or indirectly benefit humans (US EPA 2004b).

Within the context of I&E reductions, use values are defined as values related to direct or indirect human use of the resource or service in question. Uses can be direct (e.g., the harvest of recreational or commercial fish), or indirect (e.g., the contribution of forage fish to the ecological processes that provide benefit humans through other channels). Aquatic systems often provide a wide range of direct and indirect use values, including values related to products exchanged in organized markets (e.g., commercial fish and shellfish), recreational activities, nonrecreational aesthetics, and ecosystem services used off site (Johnston et al. 2002a,b, 2005). Many of these direct and indirect services are influenced by organisms lost to I&E; affected organisms are critical to the functioning of aquatic ecosystems and the services they provide (US EPA 2004).

Nonuse values are improvements in human welfare that are not linked to any present or planned future use (Freeman 2003; Johnston et al. 2003, 2005b; Just et al. 2004). Examples include existence values and bequest values. Existence values relate purely to the existence of a natural resource (e.g., being willing to pay to sustain a population of fish in an estuary because one values their existence). Bequest values are related to a desire to pass on resources to future generations. Nonuse values also include those conveyed by altruism in some instances (e.g., being willing to pay for aquatic resource improvements because they contribute to others' use or enjoyment). "Non-use values, like use values, have their basis in the theory of individual preferences and the measurement of welfare changes. According to theory, use and non-use values are additive" (Freeman, 2003). Although nonuse values can be more difficult to measure than use values, they are equally valid components of total economic benefit (Freeman 2003; Just et al. 2004). It is also widely accepted in the economic literature that non-use values may be substantial in some cases. Often, these nonuse values are significantly larger than use values (Brown 1993, Johnston et al. 2003).

Additionally, when small per capita non-use values are held by a substantial fraction of the population, they can be very large in the aggregate (Bateman et al. 2006; Loomis 1996, 2000). Failure to recognize such values may lead to improper inferences regarding policy benefits and costs. As stated by Freeman (2003, p. 138), "[i]f non-use values are large, ignoring them in natural resource policymaking could lead to serious errors and resource misallocations." The literature also advises against the use of *ad hoc* or *ex ante* assumptions regarding the magnitude of nonuse values—particularly assumptions that these values are trivial. Bateman et al. (2002, p. 75) emphasize that "it would be wrong for experts to assume that one resource is a perfectly good substitute for another" [and hence that nonuse values are trivial or small]…there are, therefore, no easy rules for determining at the outset" whether nonuse values are likely to be significant or non-significant. These guidelines apply to all benefit cost analyses, including those applicable to reductions in I&E losses at the Oyster Creek Generating Station.

Unlike use values, which usually require some proximity to the nonmarket commodity in question, nonuse values can be held by individuals regardless of physical location. For example, one can hold nonuse values for reductions in fish and shellfish mortality—or increases in aquatic species populations in a particular region—regardless of where one lives or whether one ever has the opportunity to experience affected organisms (Loomis 1996, 2000); the same applies to any nonuse value (Freeman 2003, p. 155; Johnston et al. 2005b). Understanding total economic values, including non-use values, for fishery resources is necessary to determine whether the benefits of government action to reduce impingement and entrainment losses are commensurate with the costs associated with such actions (US EPA 2004b, 2005).

Consideration of potential nonuse values is particularly important when considering the economic benefits of I&E reductions, as well over 95% of I&E losses at CWIS typically consist of either forage species or non-landed recreational and commercial species that do not have direct uses (US EPA 2004b, 2005). Although humans do not use these resources directly, they may nevertheless be affected by changes in the resource status or quality, such that they would be willing to pay to maintain these resources. For the case of reductions in I&E losses of aquatic organisms (such as that which would result from closed-cycle cooling at the Oyster Creek Nuclear Generating Station), economic theory clearly allows for the possibility of significant nonuse values, and recent empirical studies suggest that these values are likely to be large in the aggregate.

Empirical Evidence of Non-Market Use and Nonuse Benefits from I&E Reductions

There are many studies in the environmental economics literature that quantify benefits or willingness to pay (WTP) associated with various types of water quality and aquatic habitat changes, including those related to effects similar to those experienced due to I&E reductions. In addition, US EPA has conducted economic assessments of benefits related to Phase I, II and III rules under section 316(b) of the Clean Water Act which directly influence I&E in CWIS (see http://www.epa.gov/waterscience/316b/ for extensive information and materials). None of these past analyses provide a comprehensive estimate of *all* benefits associated with I&E reductions. The combined evidence from the published literature and US EPA benefit cost analyses, however, clearly and overwhelmingly demonstrates that substantial use and nonuse values are likely when closed-cycle cooling is used to reduce I&E impacts on aquatic organisms.

Given the magnitude of I&E losses and habitat impacts at the Oyster Creek Generating Station, it is likely that large market and non-market benefits would also result from I&E reductions. This conclusion is supported by both EPA's benefit cost analysis and the empirical economic literature.

Empirical Estimates from US EPA Benefit Cost Analysis

Among the most targeted and detailed estimates of economic benefits from I&E reductions are provided by US EPA benefit cost analyses conducted as part of Clean Water Act (CWA) 316(b) Phase I, II and III rule development (http://www.epa.gov/waterscience/316b/). Cost benefit analyses for the CWA 316(b) Phase I, II and III rules outlines a taxonomy organizing the most prominent categories of economic use and nonuse benefit associated with reductions in I&E losses in CWIS (e.g., US EPA 2001). This involves "four quadrants … divided by two principles: (1) whether the benefit can be tracked in a market (i.e., market goods and services) and (2) how the benefit of a nonmarket good is received by human beneficiaries (either from direct use of the resource, from indirect use, or from nonuse)" (US EPA 2001, p. 11-16). All are legitimate and theoretically quantifiable components of economic benefit, although empirical challenges may prevent the estimation of reliable quantitative estimates of value in some cases. Within this taxonomy, for general categories of benefit are highlighted (emphasis added).

> "*Market benefits* are best typified by commercial fisheries, where a change in fishery conditions will manifest itself in the price, quantity, and/or quality of fish harvests. […] *Direct use benefits* include the value of improved environmental goods and services used and valued by people (whether or not they are traded in markets). […] *Indirect use benefits* refer to changes that contribute, through an indirect pathway, to an increase in welfare for users (or nonusers) of the resource. An example of an indirect benefit would be when the increase in the number of forage fish enables the population of valued predator species to improve. *Nonuse benefits* — also known as passive use values — reflect the values individuals assign to improved ecological conditions apart from any current, anticipated, or optional use by them" (US EPA 2001, p. 11_16-17).

Taken together these benefits are often large. As part of 316(b) Phase II rule development, US EPA developed a number of case studies in which economic benefits of I&E reductions are estimated (http://www.epa.gov/waterscience/316b/phase2/casestudy/). Given significant uncertainties in the calculation of final empirical estimates, US EPA methods err on the side of underestimating total annual benefits from I&E reductions. Even given this substantial underestimation of benefits (in which entire categories of benefits remain unquantified), for the Brayton Point Station located on Mount Hope Bay in the Town of Somerset, Massachusetts, reported "[annual] values range from $9,000 to $873,000 for impingement, and from $230,000 to $27.7 million for entrainment" (US EPA 2002, p. F6-1). In present value terms, this translates to between $112,500 and $10,912,500 for impingement, and between $2,875,000 and $346,250,000 for entrainment (in 2002 dollars).[1]

Similar analysis within the transition zone of the Delaware Estuary, affecting four power plants, estimates annual benefits of "$320,000 to $487,000 for a 60 percent reduction in impingement and from $15.3 million to $27.2 million for a 60 percent reduction in entrainment" (US EPA 2002, p. B6-7). In present value terms, this translates to between $ 4,000,000 and $6,087,500 for impingement, and between $191,250,000 and $340,000,000 for entrainment (in 2002 dollars). Again, US EPA suggests that these estimates are likely to be underestimates of true benefits, as they do not include the complete range of benefits likely to result from reductions in I&E losses, and are likely to be subject to considerable uncertainty.

Similar case study analyses and empirical benefit estimates are provided for six additional case studies in different regions of the US, showing significant benefits from I&E reductions in all cases ((http://www.epa.gov/waterscience/316b/phase2/casestudy/). Although exact empirical estimates are subject to uncertainties identified in the US EPA reports, they nonetheless suggest the substantial magnitude of annual economic use and nonuse benefits that can result from the reduction of I&E losses of aquatic organisms. Similar regional and nationwide estimates were provided by US EPA for development of the Phase I, II and III rules that regulate CWIS operations to reduce I&E losses (e.g., US EPA 2001, 2002, 2004a,b, 2006; see also other documents on http://www.epa.gov/waterscience/316b/). Despite the fact that all of these analyses omitted numerous areas of economic benefit from final quantitative benefit estimates due to empirical (economic and ecological) uncertainties, the quantified portions of benefits were nonetheless large in all cases, again demonstrating the large benefits resulting from I&E reductions. Given the expectation of substantial nationwide benefits from I&E reductions, US EPA has also issued numerous information collection requests through the Federal Register for research explicitly designed to provide more exact and tailored estimates of total benefits from I&E reductions (e.g., US EPA 2005, among others).

Empirical Estimates from the Published Economics Literature

Aside from US EPA documents, the published economics literature provides significant evidence that the benefits of I&E reductions are likely to be substantial. This evidence is found both in research conducted explicitly to provide insight into the benefits of I&E reductions and similar policies with direct impacts on aquatic organisms, as well as other research that provides indirect evidence of use and nonuse values associated with improvements in aquatic organisms. Of particular note are published works that estimate large nonuse values associated with aquatic organisms and ecosystems of the type affected in Barnegat Bay by the Oyster Creek Generating Station (cf. US NRC 2006).

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[1] This assumes a conservative 8% discount rate and that annual benefits continue in perpetuity. Total benefits increase if lower discount rates are assumed.

Among available published or in-press studies, likely the most closely related to the policy context encountered at Oyster Creek is Johnston et al. (2009, 2010), which estimates total per household willingness to pay (WTP) for aquatic ecosystem changes related to improvements in small migratory fish. This research was originally inspired by the challenges encountered in benefit estimation for US EPA 316(b) regulations. Models from this research allow direct estimation of households' WTP for policies that change human industrial uses of aquatic systems to reduce harm to non-commercial fish populations. Estimated benefit functions also provide a means to distinguish WTP related to direct effects on fish from WTP related to indirect effects on other ecosystem services (Johnston et al. 2010). In addition, the choice experiment addresses species such as alewife and blueback herring that are neither subject to recreational or commercial harvest in Rhode Island, nor are charismatic species. Hence, the species affected are a close analog to the forage fish that are among the primary organisms affected by I&E at the Oyster Creek facility.

The choice experiment methods of Johnston et al. (2009, 2010) were developed for a case study addressing Rhode Island residents' preferences for the restoration of migratory fish passage over dams in the Pawtuxet and Wood-Pawcatuck watersheds of Rhode Island. Although published estimates calculate fish-related benefits as a function of the population viability of affected species, unpublished models may be used to calculate WTP per household, per fish, per year – so that results can be directly linked to ecological estimates of I&E effects denominated in numbers of fish. Models from the as-yet unpublished data, for example, estimate that WTP for a 12% increase in the number of fish passing upstream into the Pawtuxet watershed (an increment of 147,000 fish) can range from $8.03 to $20.22 *per household, per year*, depending on model assumptions. Multiplying this estimate by the number of households in the affected region (all households in the state of Rhode Island at a minimum, although broader populations likely also receive benefits; see Loomis 1996) provides an estimate of total WTP for the policy change.

Another study closely related to benefit estimation for I&E reductions is Johnston et al. (2005a). This study estimates a meta-regression analysis to identify systematic patterns in willingness to pay (WTP) for aquatic resource improvements among US residents. The analysis was initially conducted to explore benefit transfer methods for estimating use and nonuse values for fish and related resources affected by US EPA 316(b) regulations – specifically I&E reductions as part of the 316(b) Phase II rule. The resulting benefit function allows calculation of per household willingness to pay (including use and nonuse values) for water quality improvements whose primary effect is to improve habitat for aquatic species such as fish and shellfish, as a function of resource, policy, site and affected population attributes. A corollary benefit transfer application is illustrated by Johnston and Besedin (2009a), and a follow-up application to both US and Canadian residents is provided by Johnston and Thomassin (2010). Specific application methods to estimate benefits from I&E reductions in CWIS are detailed by US EPA (2004b). Methods used to apply these results for quantitative benefit estimation and benefit transfer are detailed by Johnston and Besedin (2009a). For illustrative policies providing modest benefits to fish habitat (i.e., 1 and 3 units on a ten-point scale), Johnston and Besedin (2009a) calculate an average WTP of $14.67 and $22.30 per household.

Similar estimates of WTP for habitat improvements whose primary effect is to benefit aquatic organisms such as fish and shellfish are provided by Johnston et al. (2001, 2002b) in the context of the Peconic Estuary on Long Island, NY. This study elicited the public's total WTP values for both coastal wetlands and eelgrass, using the contingent choice method. Both habitats are essential for supporting production of commercial and recreational species. These two habitat types are most frequently used in the analysis of replacement habitat needed to offset I&E losses. The study area is located between the North and Mid-Atlantic regions, and thus provides site-specific values for an estuary that is likely to be representative of values for both regions. Both eelgrass and wetlands located in the Peconic Estuary support aquatic species that are found in the Mid-Atlantic region, and that are likely to be affected by I&E (e.g., bay anchovy, Atlantic silverside, scup, summer flounder, winter flounder, windowpane flounder, weakfish, and tautog; as well as scallops and hard clams). These species include many of the same species found in the Oyster Creek region (see US NRC 2006). Methods that could be used to estimate nonuse values for I&E reductions based on a habitat equivalency analysis from the results of Johnston et al. (2002b) are described by US EPA (2004b, chapter A15). As above, these methods also suggest that relatively large per household benefits result from policies that benefit aquatic organisms such as those subject to I&E at Oyster Creek.

In addition to the above studies, Johnston et al. (2005b) estimate a choice experiment model allowing calculation of user and nonuser WTP for different outcomes of coastal wetland restoration, including direct habitat benefits for fish and shellfish. The data are drawn from "Rhode Island Salt Marsh Restoration: A 2001 Survey of Rhode Island Residents." The survey was designed to identify public values for changes in salt marsh functions provided by restoration actions (Johnston et al. 2002a). For example, the model calculates that annual WTP for a one-unit ecological improvement to fish populations (on a standardized 0-10 scale) resulting from restoration ranged from $23.41 per household among active recreational users of coastal wetlands to $10.54 among nonuser households. Analogous annual per household benefits for shellfish improvements were $27.04 and $19.25, respectively. Although these results are not designed to quantify exact benefits from I&E reductions, they demonstrate substantial annual per household use and nonuse economic values associated with the type of fish and shellfish resources negatively affected by once-through cooling at the Oyster Creek Generating Station.

Total *annual* benefit estimates require multiplying annual benefit estimates such as those cited above by the number of households in the affected region. Often, benefit estimates are generated for political jurisdictions such as states (Johnston and Duke 2009). If similar benefits were received by New Jersey households from improvements to fish and shellfish, per household annual benefits would then be multiplied by approximately 3,064,645 (the number of households in New Jersey according to the 2000 US Census) to generate a total annual benefit measure. However, benefits from environmental policies can extend far beyond statewide populations, so that aggregate benefit measures can be much larger than those realized by residents in a single affected state (Loomis 1996, 2000). Additional discussion of the Loomis (1996) results is provided below, and is particularly relevant in the present case.

All of the above studies use some form of stated preference (survey based) valuation methods; these are the only methods capable of quantifying both use and nonuse values (Freeman 2003). However, other research has quantified non-market use benefits to recreational anglers of improvements in fish populations, such as those that may be encountered when I&E losses are reduced. Johnston et al. (2006a,b), for example, use meta-regression analysis to quantify per fish benefits of recreational harvest. A similar model is found in Stapler and Johnston (2009). The data are drawn from non-market valuation studies that estimate the marginal value (or WTP) that anglers place on catching an additional fish. This model was estimated originally to quantify benefits from I&E reductions as part of 316(b) benefit cost analysis. Applying this model to the Mid-Atlantic region, WTP from $0.93 to $5.95 *per angler, per fish*, depending on species (Johnston and Besedin 2009b). Aggregated over the potential effects of I&E losses on regional fish populations, aggregate losses in recreational benefits can be substantial. Estimates of similar magnitude are provided by US EPA (2004b, Chapter A11) from a random utility model (RUM) of recreational fishing choices among anglers. It is important to note that these estimates only reflect the non-market use values received by recreational anglers—other areas of market and non-market benefit are not included in these estimates. Within the literature cited by Johnston et al. (2006a,b) are dozens of additional studies that estimate recreational use benefits associated with various types of fish species potentially affected by I&E, all estimated using established and accepted economic methods.

The studies noted above are emphasized in the present memorandum because results are closely related to the types of benefits that would result from the use of closed-cycle cooling at the Oyster Creek Generating Station, compared to current operations using once-through cooling. In addition, the broader environmental economics literature also includes a large number of studies demonstrating the existence and magnitude of often-substantial benefits from policy changes whose primary effect is to enhance, restore or protect fish resources. Other studies have estimated the value of changes in catch rates or populations of select recreational and commercial species, charismatic species such as salmon, or changes in water quality that affect fish. For example, Olsen et al. (1991) conducted a survey of Pacific Northwest residents, including both anglers and non-anglers, to determine their WTP for increasing Columbia River Basin salmon and steelhead runs. When considering results of this study and the many others like it (e.g., Cameron and Huppert 1989), it is important to note that these research efforts value only a small number of recreationally important species. As noted above, there may be other areas of use and nonuse benefits, such as those associated with improvements to forage fish, which are substantial in many policy contexts.

Similar estimates are provided by Loomis (1996) for the restoration of fish in the Elwha River of Washington State. This study is notable because it demonstrates that *benefits for fish improvements in a single river or estuary can be realized by all households in the US—and indeed that 97% of benefits were received by out-of-state residents*. Loomis (1996) estimates WTP of $6,268 million for fish restoration in the Elwha River, once statewide and national benefits are aggregated appropriately. Based on these and similar findings elsewhere (Loomis 2000; Bateman et al. 2006), it would be reasonable to suspect that benefits for I&E reductions at the Oyster Creek facility could be realized by residents from all US states, in addition to benefits realized in New Jersey alone.

Dozens of other published studies in the US and elsewhere, including Johnston and Besedin (2009b), Hicks (2002), Pendleton and Mendelsohn (1998), Hanley et al. (2006a,b), Morrison and Bennett (2004), Do and Bennett (2009) and others, demonstrate substantial use and/or nonuse benefits from ecosystem and other policy changes that improve conditions for fish. Milon and Scrogin (2006), for example, show that households in Florida are willing to pay $17.98 per household, per year, for improvement to estuarine species such as Pink Shrimp, Mullet and Sea

Trout in the Everglades—again demonstrating significant use and nonuse benefits of policies that improve ecological conditions for aquatic organisms.

Summarizing the Evidence

Combined results from US EPA benefit cost analyses, the published literature, and as-yet unpublished data from large scale research efforts provide overwhelming evidence of the market and non-market economic benefits that result from policies that prevent damage to aquatic organisms such as fish and shellfish. These include estimates from research conducted specifically for the purpose of evaluating partial or more complete benefits of I&E reductions in CWIS (e.g., Johnston et al. 2005a, 2006a,b, US EPA 2001, 2004a,b, 2006; see also other documents on http://www.epa.gov/waterscience/316b/), as well as other research from closely related policy contexts demonstrating significant non-market economic benefits resulting from the protection or restoration of fish resources (e.g., Loomis 1996; Olsen et al. 1991; Cameron and Huppert 1989; Johnston et al. 2002a,b, 2005b, 2010, Hanley et al. 2006a,b, Morrison and Bennett 2004, Do and Bennett 2009). Although effects on commercial fisheries may provide important and measurable benefits due to I&E reductions[2], evidence from these and other published studies suggests that quantified market benefits from I&E reductions (e.g., including effects on the net benefits of commercial fisheries harvests) are likely to be a small component of total benefits. That is, total use and nonuse non-market benefits are likely to dwarf benefits that are measurable in markets.

Evidence also suggests that nonuse benefits resulting from I&E reductions are likely to be large in the aggregate (cf. Johnston et al. 2005b, 2009, 2010, Loomis 1996). As stated by US EPA (2004, p. A12_1), "use values alone may seriously understate total social values" associated with I&E reductions. Brown (1993), for example, reports that in many studies, total values exceed direct use values by greater than a factor of two. Similar findings are reported by Johnston et al. (2003) for aquatic resource improvements. Hence, any statements regarding the specific size of benefits from I&E reductions at the Oyster Creek Generating Station—and particularly that these benefits might be smaller than costs—can only be considered premature and speculative without a comprehensive estimate of national use and nonuse benefits that would result. Broad evidence from the economics literature suggests that these benefits are likely to be very substantial, particularly in the aggregate.

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[2] For information on the significant market benefits of US commercial fisheries, see National Marine Fisheries Service (2006b).

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