

# QUANTIFICATION OF INTERDEPENDENCIES BETWEEN ECONOMIC SYSTEMS AND ECOSYSTEM SERVICES: AN INPUT-OUTPUT MODEL APPLIED TO THE SEINE ESTUARY

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The aim of this paper is to assess the contribution of an ecological-economic input-output model towards two of the precepts advocated by the sustainability strategy of integrated coastal zone management and Post-Normal Sciences. According to these precepts, decision support tools should offer a holistic perspective and handle high uncertainty. Non-sustainability seems to be partly due to an inadequate use of “narrow-system-boundary” tools that are non-holistic. Consequently, they fail to capture important ecosystem services and ignore interdependencies between them. To comply with the precepts, our method firstly allows environmental assets to be evaluated in multiple units. Secondly, it integrates economic data to results from researches in natural sciences. Both enable coverage of interdependencies between ecosystem services. An application to the Seine Estuary addresses the impacts of maritime transportation infrastructures on nursery habitats for commercial fish (*solea solea* sp.). Due to the high level of uncertainty and lack of data on the state of most fish stocks in Europe and given the unsustainable harvest of the remaining stocks, measures applied to fish habitats on the basis of the precautionary principle might acquire greater political acceptability in the future. Out of a total of 44 fish stocks in European fishing zones, the state of the stock is unknown or undefined for 57%, the harvest is sustainable for only 4%, and the remaining 32% is overfished (ICES, 2008). In response to these figures, the I-O model developed in this paper is used to answer the following question: what would be the ecological and economic impact of a fish nursery restoration measure applied on the basis of the precautionary principle and the principles that the polluter should pay, two principles stated in the Marine Strategy Framework Directive (European Parliament and Council, 2008). On the basis of these principles, the environmental measure that we consider consists in restoring 20% of the high fish density nurseries destroyed between 1834 and 2004. The security margin ensuring the precautionary principle is quite important since the scenario would consist in recovering the surface that existed in the estuary in 1890-1915. The expected impact is an increase in fish stocks, which should increase the resilience of fish populations to fishing activities and their capacity to regenerate for the future. Our results show that the restoration of a total of 24.38km<sup>2</sup> of subtidal sandy nursery areas over the period 2004-2015 would result in a stock of sole in 2015 that exceeds the “business as usual” scenario by 17.5% – 22.9%. In spite of high restoration costs, the negative macro-economic impact is very low. However, on the sector level, a trade-off results between nurseries and the sectors of mines, harbors and fossil fuel manufacturing, which see high decreases in their benefits compared the scenario “business as usual”. However, our paper suggests that enlarging the allocation rule of restoration costs to indirect polluters of third order (tertiary sectors) could strongly reduce the economic impacts. This shows that high restoration costs are not a problem *per se* but rather a question of cost allocation.

## References

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