doi:10.1111/j.0361-3666.2008.01064.x

Indirect assessment of economic damages from the Prestige oil spill: consequences for liability and risk prevention

María Dolores Garza, Albino Prada, Manuel Varela and María Xosé Vázquez Rodríguez[1]

The social losses arising from the Prestige oil spill exceed the compensation granted under the IOPC (International Oil Pollution Compensation) system, with losses estimated at 15 times more than the applicable limit of compensations. This is far above the level of costs for which those responsible for hydrocarbons spills are liable. The highest market losses correspond to sectors of extraction, elaboration and commercialisation of seafood. However, damages to non-commercial natural resources could constitute an outstanding group of losses for which further primary data are needed: these losses would only be compensable under the current system by means of a refund for cleaning and restoration costs. Results show that, in Europe, the responsibility for oil spills in maritime transport is limited and unclear. The consequence of this is net social losses from recurrent oil spills and internationally accepted incentives for risky strategies in the marine transport of hydrocarbons.

Keywords: economic valuation, fisheries, oil spill damages, passive use values, recreation, tourism

Introduction

Calculating the social cost of an oil spill requires considering a more comprehensive set of damages than the limited assessments carried out for compensation purposes. In the social approach, represented in Table 1, both private costs and collective or public damages should be included. Private costs include losses to fisheries and the seafood sector (transport, processing and marketing firms) and to tourism on coastal areas. These are private costs because property values are well-defined and thus only a limited group of individuals is affected. The advantage of private costs is that they are associated with economic activities for which market values are available. In addition, the liability framework of the International Oil Pollution Compensation (IOPC) Fund, a convention adopted under the auspices of the International Maritime Organization (IMO), fully compensates for these losses, once quantification and proof are provided by the affected individuals or firms.

Collective or public losses are usually identified with cleaning and restoration costs, which are also related to goods and services such as workers' salary or the price or rent of hydrocleaners. The IOPC/IMO system compensates for cleaning and restoration

Published by Blackwell Publishing, 9600 Garsington Road, Oxford, OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA

Table 1 Social cost of an oil spill

	TYPE OF COST	TYPE OF VALUE	IOPC/IMO COMPENSATION
Cleaning and restoration	PUBLIC	MARKETED	yes
Fisheries and related sectors	PRIVATE	MARKETED	yes
Tourism	PRIVATE	MARKETED	yes
Recreation	PRIVATE	NON-MARKETED	no
Non-use or passive use	PUBLIC	NON-MARKETED	no

Source: authors' elaboration.

costs under the assumption that natural resources and the environment will completely recover their previous state and will show exactly the same characteristics as before the spill. However, under the IOPC/IMO system, there is no compensation available for lost recreational opportunities for residents (use of beaches and landscape) and non-use or passive use losses (cultural, non-use and heritage values) that occur in the time interval between the oil spill and the period when restoration is completed—the so called 'interim losses'. These social, non-marketed damages go uncompensated because they have no market value and therefore no monetary estimate of losses. There are, however, direct or stated preference valuation methods available, which have been accepted as reliable for estimating social non-marketed losses outside of the IOPC/IMO system. In the Exxon Valdez oil spill, a billion dollars were paid by Exxon to compensate for non-marketed losses and the stated preference techniques have since been included in the NRDA (Natural Resource Damage Assessment) categories and procedures under the Comprehensive Environmental Response, Compensation and Liability Act.

On 13 November 2002, the Prestige oil tanker sprung a leak 30 miles west of Galicia, in north-west Spain. The 25-year-old single-hull ship was transporting 77,000 tons of heavy fuel oil from Lithuania to an undetermined destination. Under a Bahamian flag, it was owned by a Greek shipping company and chartered by an Anglo–Swiss company. The tanker was towed north-west and then south-west until, on 18 November, having sailed for five days with a gash in its hull, it broke in two and sank 130 miles off the coast. The bulk of the 77,000 tons of heavy fuel spilled into the Atlantic Ocean. The pollution mainly affected Spain's north-west coastline, polluting approximately 1,000 km of shoreline in Galicia alone, resulting in losses to one of the European Union's main fishing communities but also damaging important sites of ecological and recreational interest and the tourism industry.

The social impact of pollution events has been examined in a number of studies, and progress has been made in our understanding of the magnitude of the total costs associated with the release of toxic or hazardous substances into the sea, both from a theoretical and an applied point of view. Although the focus was initially on economic losses (Bonnieux et al., 1980; Collins et al., 1998; Grigalunas et al., 2001;

Hanemann and Strand, 1993), the Amoco Cadiz oil spill raised the first questions about the valuation extent and procedures (Bonnieux and Rainelli, 1991 and 1993; Grigalunas et al., 1986 and 1998; Grigalunas and Opaluch, 1993; Hay and Thebaud, 2003). Since then, some studies have adopted a more general framework that includes collective non-marketed losses (Carson et al., 2003, and Cohen, 1995, in the Exxon Valdez case; Carson et al., 1996, in California; Bonnieux and Rainelli, 2004, after the Erika oil spill). The magnitude of social losses compared with the available compensation has supported a new framework for liability in the United States, but in Europe the IOPC/IMO system was ratified only after the case of the Prestige tanker.

This article presents an economic assessment (in monetary terms) of social damages from the Prestige oil spill in Galicia, where approximately 60 per cent of the coast was affected. Secondary data were used to illustrate the overall magnitude of losses. The social cost approach has been adopted to show the limitations of the European institutional framework of liability. Under the current liability framework in Europe—the IOPC/IMO system—claims based on collective non-marketed losses are still not allowed and the 'polluter pays' principle is not fulfilled. Consequently, incentives to continue with risky strategies in the maritime transport of oil substances remain.

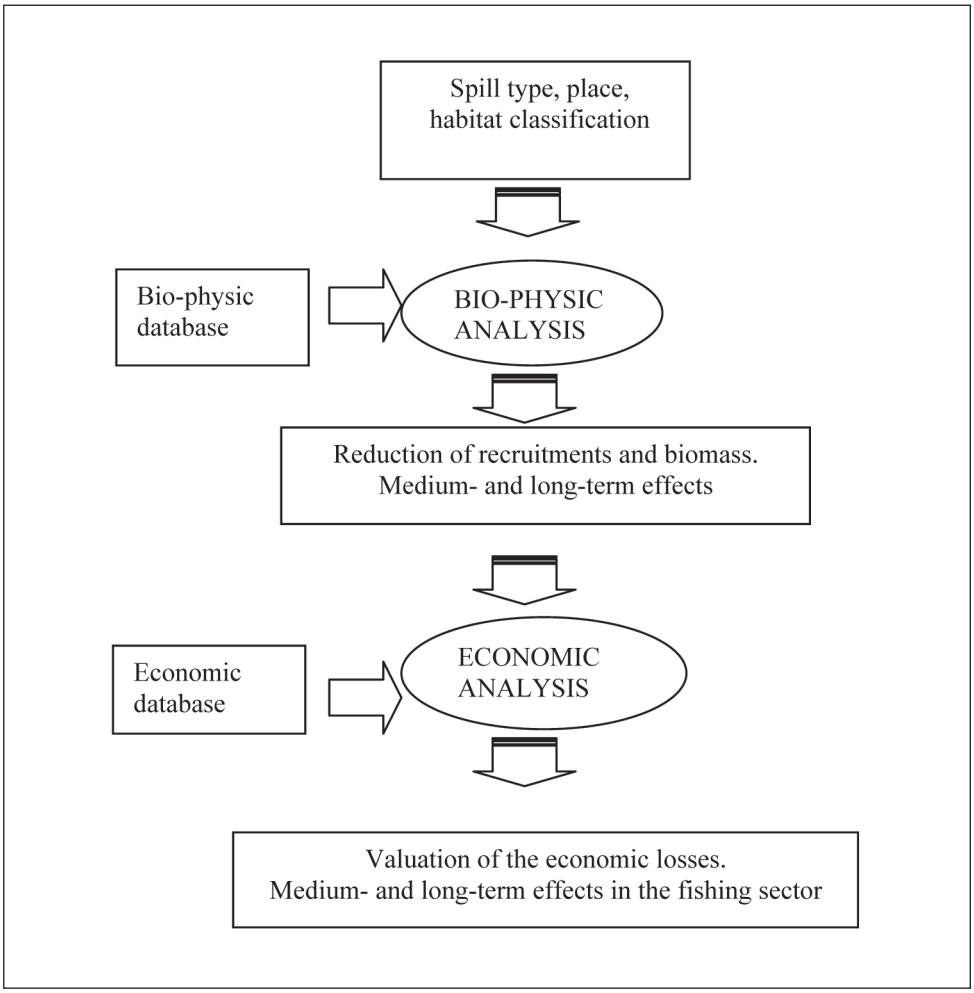
The article is organised as follows. First, economic impacts in fisheries are quantified according to reports from the sector. Then, an estimation of damages to tourism and recreation is presented and the importance of non-use or passive use losses is highlighted, based on the value transfer from studies on other oil spills.

Valuation of economic damages to fisheries and related sectors

Regarding the fishing and aquaculture sector, we should distinguish the short-term effects (for a year or less) from the medium/long-term effects (between one and five years, or more). In the short term, the economic losses are estimated through the variations in the catch of affected species (private and marketed costs). As an example, in the fishing sector, we consider catch and effort (preferably in monthly data) by boat and by species, which are then compared with the values of the same variables in the year before the spill. From these data the value of the loss is estimated using input-output analysis to approach production and global value-added losses. Other important losses, besides fishing, will be observed in the commercialisation and elaboration industry of fishing products.

Regarding medium and long-term valuations, it is necessary to know the initial situation and the evolution of the affected marine resources. This includes losses of adults and juveniles for different species groups (larger in sedentary species); loss of larvae, rebounding on future recruitments and on the biomass in the medium term; and risk of genetic and behaviour alterations. In all these aspects, economics depends on biology because valuation will only be possible insofar as biological estimations are available (see Figure 1 for a description of the interdisciplinary analysis).

Figure 1 Description of the valuation process



The estimation of impacts is complex and somewhat controversial. The results presented below must be taken as approximate and strongly depend on available information sources. We will first describe the importance of the fishing sector in the regional economy of Galicia. As Table 2 shows, Galicia generates about 10 per cent of the fishing production and 18 per cent of the aquacultural production in the European Union (EU–15), and has a similar fishing fleet, in number and capacity, to France or the United Kingdom. In Galicia, around 32,700 people are employed directly in the fishing sector, which represents almost 11 per cent of European Union fishing employment. This concentration of the fishing activity in the Galician coast means that the relative weight of this sector in the Galician economy multiplies by ten the European average, because in the EU–15 the fishing and aquacultural sector contributes only 0.2 per cent of GDP, while in Galicia that relative weight is 2.4 per cent.

Table 2 The Galician fishing sector within the European Union–15 (2001)

		EU–15	Spain	% EU	Galicia	% Spain	% EU
Fleet	Number of boats	99,170	17,972	18.1	*7,754	43.1	7.8
	Capacity (thousands GRT)	2,053	589	28.7	204	34.6	9.9
Production	Fishing unloading (thousands of tons)	4,594	950	20.7	**475	50.0	10.3
	Value of fishing unloading (EUR thousands)	5,516	1,602	29.0	**801	50.0	14.5
	Aquaculture production (thousands of tons)	1,373	321	23.4	253	78.8	18.4
	Value of aquaculture production (EUR thousands)	2,459	277	11.3	143	51.6	5.8
Employment	Aquaculture and fishing	308,071	83,120	27.0	32,700	39.3	10.6
Income (%)***	GAV fishing sector / GDP	0.2			2.4		

Notes:
* Auxiliary fleet of aquaculture is not included.
** Approximate data.
*** Fishing and aquaculture included.
GRT = gross register tonnage; GAV = gross added value; GDP = gross domestic product.

Source: European Commission (2001).

Approximately 80 per cent of the Galician coastal fleet operates in the bays of Vigo, Pontevedra, Arousa and Fisterra, as well as most of the aquacultural facilities (mussels cultivated on rafts) and shellfish-gathering areas. This situation, given the large extent of the coastal area affected by the Prestige, means that we should estimate a high severity of effects. Other activities were also indirectly affected, especially canned fish production, the frozen-fish industry and the commercialisation of all marine products.

The data for indirectly approximate short-term damages were obtained from a comprehensive report of the regional Chamber of Commerce (Cámaras de Galicia, 2003). According to this report, the fishing sector suffered a loss of sales income of EUR 1.39 billion in 2003, of which EUR 320 million correspond to losses in direct extractive activities (fishing, aquaculture and shellfish-gathering) and the rest to losses in related sectors (see Table 3). The aquaculture sector includes rafts of mussels and oysters, which are the two activities affected by the fishing ban. Marine farms are not involved in these figures.

Taking these estimations as a reference, we consider the information of the last input-output tables for Galicia. In the input-output analysis the quantities of input and output for a given time period, usually expressed in monetary terms, are entered into an input-output matrix. Within this it is possible to analyse what happens within

Table 3 Losses estimated in the fishing sector for 2003

Subsectors	Number of jobs	Sales income (EUR millions)	Impact coefficient	Losses in sales income (EUR millions)	Value added/ sales income	GDP losses (EUR millions)
Fishing in Galician waters	28,500	220	80%	176	64.9%	114.2
Shellfish-gathering	9,000	60	90%	54	64.9%	35.0
Aquaculture	4,700	120	75%	90	64.9%	58.4
Commercialisation sector	6,500	1,750	40%	700	58.7%	410.9
Canning industry	18,000	850	30%	255	17.2%	43.9
Frozen-fish industry	3,000	700	10%	70	17.2%	12.0
Other related industries*	10,800	300	15%	45	17.2%	7.7
TOTAL	**80,500**	**4,000**	**35%**	**1,390**	**49.1%**	**682.1**

Notes:
* Mainly, fishermen's associations, ice factories, naval repair work, packing, containers, machinery and equipment, transport, hotels and restaurants.

Sources: Cámaras de Galicia (2003) and authors' elaboration based on data from the Instituto Galego de Estatística (2001).

and across various sectors of an economy. In particular, we are interested in the whole sea-related industry as well as in the fishing sector. We then use the ratio of value added over the total value of the production in each subsector: 64.9 per cent in fishing, shellfish-gathering and aquaculture; 58.7 per cent in the commercialisation sector; 17.2 per cent in the elaboration industry. Based on these data, we obtain a decrease of value added for the fishing sector of EUR 207.6 million and of EUR 682.1 million in the sea-related industry. This decrease would translate into a loss of about 0.6 per cent in Galician GDP if only considering the fishing activity, and of about 2 per cent if all the activities directly related with the fishing sector are considered.

Valuation of losses to tourism and recreation

The Autonomous Community of Galicia can be considered the region most affected by the damage caused by the Prestige oil spill. As a coastal region, situated in the north-west corner of the Iberian peninsula, almost 500 of its 700 beaches received, to different degrees, fuel-oil spots during the weeks and months following the shipwreck (CES de España, 2003). In the other Atlantic regions of Spain that were affected (Basque Country, Cantabria and Asturias) about 250 beaches were polluted.

Although Galicia does not have such an intense tourist demand as some Atlantic French regions (such as Aquitaine or Britanny), it is above average compared with other affected Spanish regions. Galicia receives 40 per cent of the overnight tourism

that arrives on the Spanish Atlantic coastline, stretching from the frontier with France to the frontier with Portugal. To estimate tourism losses for the regional economy, tourist expenditure is considered,[2] which is worth ten per cent of the Gross Added Value (GAV) of the economy and a larger percentage in employment terms.

Official statistical sources[3] on the tourist sector directly relate half of the tourist-recreational uses of the coast (beaches, landscapes, gastronomy) registered in Galicia in 2003 (the base-year for the impact) to enjoyment of the coast. We distinguish three main types of these uses: hotels or regulated accommodation, unregulated accommodation (holiday homes, apartments, weekend residences, family homes) and trips. Hotels[4] receive more than 12 million overnight stays, of which 62.8 per cent come from the rest of Spain, 29.3 per cent from Galicia, and only 7.7 per cent from foreign countries. The unregulated accommodation represents more than 27 million overnight stays, 42.5 per cent of which are Galician residents. Finally, one-day trips without overnight stays account for more than 20 million tourists, mostly Galician residents, although there is a substantial flow of visitors from Portugal, who comprise 17 per cent of the total.

All these uses have been affected in some way by the environmental impact of the Prestige oil spill, both with quantitative consequences (decrease in uses—lodgings, days of visit—during 2003) and with qualitative effects (decrease in visitor satisfaction). To obtain estimations of these losses (Table 4), we will first transfer estimations obtained for other oil spills in the European Atlantic coast; then we will use indicators based on statistics from the tourism sector in 2003 (published in 2004) in Galicia and Spain.

Results from previous studies on the Erika and Amoco Cadiz oil spills show a 15 per cent decrease in uses linked to the coast. For the Erika case, in France, we use data from CESRPL (2000); for Amoco Cadiz, also in France, we use Bonnieux and Rainelli (1993 and 2004) and the Assemblée Nationale (2000). From tourism statistics, we find a five per cent decrease in all tourist flows according to the data from the Institute of Tourism Studies (Instituto de Estudios Turísticos) in Madrid.[5] In both scenarios, the assumptions are that: the ratios of daily expenditure remain constant compared with the base-year; Galician residents' overnight stays in unregulated accommodation is not affected; and the satisfaction in the remaining uses was reduced by ten per cent.

The estimation of losses (Table 4) is placed just above six per cent of the sector's sales turnover but far above the estimations[6] of the IOPC Fund for the whole of the Spanish tourist sector: EUR 31.7 million to EUR 44.4 million. A reason for this difference is that the Fund only quantifies the smaller use damages for the regulated sector (only these uses can be claimed under the current system). Our results show a minimun estimation of EUR 36.4 million in Galicia alone (scenario II for hotels).

The decrease in hotel stays is lower than the impact on other uses (trips and unregulated tourist accommodation), and the loss of satisfaction of visits is similar to the losses resulting from the decreased use of the coast. Damages in active uses linked to recreation on the coast comes close to the limit of responsibility of the Fund for

Table 4 Estimation of tourist and recreational losses (EUR millions, 2003)

	I	II
DECREASE IN USE	124.6	101.0
Hotels	54.7	36.4
Trips	27.0	36.0
Unregulated accommodation	42.9	28.6
DECREASE IN UTILITY OF RECREATION	85.8	86.9
Unregulated accommodation	8.9	8.9
Remaining uses	76.9	78.0
TOTAL AMOUNT OF LOSSES	**210.4**	**187.9**

Sources: for column I, data transferred from studies of other spills; for column II, data from the Instituto de Estudios Turísticos.

all damages (including commercial fishing, fighting against pollution, waste management, recovery of ecosystems). Tourism losses are about 0.7 per cent of GAV of Galicia, in addition to losses to the fisheries sector, which are worth at least 0.6 per cent of GAV.

Passive use losses: an intangible factor?

The impact of the Prestige oil spill on the natural heritage of Galicia's coastline was considerable. Most of the Galician coast is broken up by '*rias*' (bays), with high biodiversity and extremely sensitive ecosystems including wetlands, sandbanks and diverse areas of great ecological interest. In February 2003, approximately 1,000 km of this shoreline was affected to a greater or lesser degree by the oil spill. The impact was worst and most persistent in rocks, cliffs, swamps, dunes and the seabed, where natural cleaning is also more difficult and human intervention more harmful. Most of these coastal ecosystems are legally protected, such as those in the Atlantic Islands National Park (the only Galician national park of the 13 in Spain). About 38 endangered species of flora and fauna live in these protected areas.

The current regime of compensations in the IOPC system covers environmental losses 'until the reasonable costs of cleaning and restoration', under the assumption that the environment can fully recover its state prior to the incident through its own natural processes. In Spain, the costs of cleaning and restoration of the Prestige oil spill amounted to EUR 559 million, but only a very small percentage of this figure could be reimbursed by the polluter's insurance. Given the extent of the loss, we contend that this is an undervaluation of the damages caused to passive uses of the natural heritage in this region.

The amount of cleaning and restoration costs of some of the most recent and known oil spills are presented in Table 5. The Amoco Cadiz spill generated many

Table 5 Cleaning and restoration cost in some oil spills

Oil spill	Type	Thousand MT (metric tons)	Cost (millions)	Cost per MT	I	II
A. CADIZ (1978)	crude	200	EUR 134	EUR 650	50%	37%
E. VALDEZ (1989)	crude	35	USD 3,100	USD 70,454	100%	35%
ERIKA (1999)	fuel	20	EUR 124	EUR 6,200	–	15%
PRESTIGE (2002)	fuel	60	EUR 559*	EUR 10,666	15%**	–

Notes:
Column I is the percentage of the compensation finally paid compared with total cleaning and restoration costs.
Column II is the cleaning and restoration costs as a percentage of the total estimated damage.
* Result of the sum of the following costs: EUR 184 million of cleaning at sea, EUR 315 million of cleaning along the coast, EUR 60 million to extract the fuel that remained in the vessel.
** Percentage estimated by IOPC (92FUND/EXC.22/8/1) in the executive committee meeting of May, 2003.

Sources: European Commission (2000); data on column I and II from the Department of Applied Economics, University of Vigo.

economic studies (Bonnieux and Rainelli, 1991), including a valuation of the work of volunteers and soldiers. The unit mitigation costs obtained by these authors was around USD 650 per ton (in 1978). Eighty-five per cent of the IOPC Fund's final payments were related to cleaning and restoration costs—but these costs were still less than 40 per cent of the overall estimated damages.

The Exxon Valdez case is an unavoidable reference point mainly because of Exxon's direct payment of all mitigation costs (USD 2.1 billion) and its agreement to provide a restoration fund (worth USD 1 billion). Consequently, the cost of this event is the highest in Table 5. The cost per ton of oil in the Erika spill was higher than that in the Amoco Cadiz because the oil was in fuel form, which is more polluting than crude. The Prestige oil spill is, in several aspects, similar to the Erika: in the type of hydrocarbon spilled; in the work of volunteers (unpaid); and in the difficulty of extracting the fuel that remained in the vessel and giving it suitable treatment.

The amount of cleaning and restoration costs in the Prestige case (EUR 559 million) is a clear example of the limitations of the IOPC system, which only covered EUR 170 million of the total damages, despite the fact that cleaning and restoration costs are an undervaluation of environmental losses.

In general, losses of natural heritage do not translate directly into a decrease of income, and, as a result, the economic estimation of these losses is usually considered impossible. However, the natural heritage has important social functions or non-use values, among which are included:

- *Existence values:* the value that society assigns to preserving a resource, even though any current use or future use will not be carried out.
- *Altruistic values:* when individuals show certain concern about the availability of the resource for the benefit of others.
- *Value of legacy:* concern about future generations and a desire for them to have the option of enjoying the environmental resource.

In terms of these non-use values, a pioneering study (Carson et al., 2003) was carried out, financed by the State of Alaska, that estimated the impact of the Exxon Valdez spill on non-use values or passive use values of natural resources, with the aim of claiming economic compensations for damages to these values. Prince William Sound, Alaska, has invaluable ecosystems and protected status as National Park, National Monument and National Wildlife Refuge. The Exxon Valdez case showed that ignoring non-use or passive use values in assessing damages from the spill would send the message that natural resources set aside for conservation could be harmed at little or no cost to the responsible party.

Consequently, an economic study (Carson et al., 2003) was carried out in the Exxon case based on the contingent valuation (CV) method (a stated preference technique). Briefly, this method simulates a market by means of a questionnaire, in which individuals are asked to express their agreement or disagreement (vote for or against) certain prevention measures with a related cost.

It is generally recognised that only stated preference methods (Mitchell and Carson, 1989; Carson et al., 2001) estimate non-use values. The debate within the economics community, instigated by the Exxon Valdez spill, included both the conceptual underpinnings of non-use values and the technique for its measurement. However, this method has also been the target of the sharpest criticism, much of which is contained in the Exxon-sponsored volume (Hausmann, 1993), mainly based on the hypothetical character of the simulated market. The assesment of these comments, carried out by the National Oceanic and Amospheric Administration panel, concluded that CV studies convey 'useful information' for damage assessment provided it follows a number of 'stringent guidelines' (Arrow et al., 1993). The recommendations of this panel influenced regulations and the academic debate on CV.

In the Exxon study, the scenario presented to US citizens was the possibility of implementing certain preventive measures that would diminish the probability of a similar accident causing the same damage in the bay of Alaska in the near future. The interviewees could vote in favour of the proposed measures, which came at a price, or against measures and accept the risk, without cost. In this study the estimation of non-use losses by household, based on the median, was around USD 31, and around USD 97 dollars if the mean was used (Carson et al., 1992). However, since the report of 1992, substantial progress has been made on estimating models of the willingness to pay (WTP) distribution and adjusting the problems associated with the mean, which is the theoretically correct estimator. In a more recent article (Carson et al., 2003), calculations have been made with the new adjusted models and result in a mean annual WTP of about USD 54.

Value transfer is a valuation technique that consists of adapting results from existing studies to obtain estimations of value for other goods with similar characteristics, without defining and applying a new empirical research. The main advantage of the value transfer is the saving of time and monetary cost needed for a new valuation study: this makes it a cost-effective and interesting alternative when a research group or an administration need some preliminary assessment. The disadvantage is

Table 6 Non-use values lost for 2003 in the Prestige case, based on value transfer

Case	Reference	Mean WTP per household*	Total WTP in the Prestige (EUR million)**
Exxon Valdez	Carson et al. (1992) Carson et al. (2003)	USD 97.18 USD 53.61	1,564,986 863,335
California	Carson et al. (1996)	USD 76.45	1,231,150
Galicia	Prada (2001)	EUR 114.00	1,368,000

Notes:
* Exchange rate EUR/USD (30/06/2007) from European Central Bank, not adjusted by price change.
** Extrapolation for Spanish households (12,000,000).

Source: Instituto Nacional de Estadística (2001).

the transfer error associated with the transfer process, which depends on the number and quality of adjustments carried out.

To obtain some preliminary assessment of the magnitude of passive use losses in the Prestige case, we will base the assessment on value transfers from other oil spills, taking the mean WTP per household obtained in the study site and using it to obtain the total loss for the affected population in the Prestige case, the policy site. For example, based on the transfer of the mean WTP from the Exxon Valdez study (Carson et al., 2003), non-use losses for the Prestige would reach EUR 863 million.

A recent estimation for environmental damages caused by a hypothetical spill of crude on the California coast has been carried out by Carson et al. (1996). In this case, the WTP per household and year for the prevention of future damage to the coastline and wildlife was USD 76.45. Without upgrading the monetary units of 1996 and keeping in mind that in the Prestige case it is fuel and not crude, we would obtain a WTP[7] price of EUR 1.231 billion for avoiding damage to the natural heritage. The estimation of this item is approximately five times higher than the compensation limit of the IOPC Fund.

As a reference we may also compare the results obtained directly in a contingent valuation study of the Cies Islands (Prada, 2001), part of the only Galician National Park. In this study, non visitors were willing to pay EUR 6 per household only for conservation (non-use value), and for a single protected area. If there are 19 coastal protected sites in Galicia, a simple calculation indicates that the WTP for the whole would be approximately EUR 114 per household (a similar value to that obtained by Grigalunas and Opaluch [1993] in the case of the Nestucca in Washington, which was USD 95 per household). After aggregating this individual result to the total population, the result would be an amount of EUR 1.368 billion (Table 6).

Summary of results and conclusions

In short, if we summarise the estimations obtained (Table 7), adding private and collective losses, and marketed and non-marketed estimations, the total amount of

Table 7 Summary of indirect estimation of losses in Galicia in 2003

			EUR million 2003	% total
PUBLIC	Marketed	Cleaning and restoration	559	24.4
	Non-marketed	Recreation	86.9	3.8
		Biodiversity	863.3	37.7
PRIVATE	Marketed	Fisheries and related sectors	682.1	29,8
		Tourism	101.0	4.4
TOTAL MARKETED			**1,342.1**	**57.2**
TOTAL NON-MARKETED			**1,002.8**	**42.8**
TOTAL			**2,344.9**	**100.0**
IOPC COMPENSATIONS' LIMIT (Prestige)			**170**	
NEW IOPC COMPENSATIONS' LIMIT (16/05/03)			**940**	

Source: authors' elaboration.

losses using the most conservative estimations for all the items, multiplies by almost 14 times the limit of the applicable environmental responsibility in the Prestige case, which amounts to EUR 170 million. The cost is also higher than—more than double—the new limit of the IOPC Fund (16/05/03) of EUR 940 million.

However, this estimation suffers from various problems. In some cases the different costs do not correspond to equivalent periods of time. Thus, for example, the costs associated to the smallest tourist-recreational use and in the sea-industry complex have only been calculated for the year 2003; the expenses in cleaning and restoration probably exceed this year and will be prolonged for some years more. Evidently, the losses in passive use values are related to a much longer timescale because the ecosystems need a long time to recover. As an example, the effects on the natural environment of the Exxon Valdez spill in Alaska still persist about 19 years later. The results presented here are indicative of the magnitude that direct on-site estimations may reach.

We may also observe, bearing in mind the limitations due to the indirect character of the estimation, the importance of the non-marketed losses in the total amount of losses—approximately 43 per cent. The loss in passive use values (about 38 per cent) would go beyond those in fishing, elaboration sectors and commercialisation of seafood (about 30 per cent). The use of cleaning and restoration costs, as the only figure for losses related to the ecosystem, results in a serious underestimation due to the fact that interim losses in recreation and biodiversity are not considered.

Given the above, it is clear that, in Europe, the responsibility for oil spills that occur in maritime transport is not only limited but also unclear. The intervention of the IOPC Fund implies that the petroleum sector as a whole meets the cost of the damage, diffusing liability so that the proportional part of the compensation paid by the pollutant is very low in comparison with the damage caused. The opportunity to

change the system through the recent European directive on environmental liability[8] was lost and oil spills resulting from maritime transport of hydrocarbons remain within the IOPC compensation system. European Union decision makers should not minimise this problem, because the current liability framework for oil spills remains an incentive for companies to choose risky strategies in the marine transport of hydrocarbons.

Acknowledgement

We would like to thank the Consello Económico e Social de Galicia (Galician Economic and Social Council) for financing the project, 'Economic, Social and Environmental Effects of the Prestige Oil Spill'.

Correspondence

María Xosé Vázquez Rodríguez, Departamento de Economía Aplicada, Universidad de Vigo, As Lagoas-Marcosende, 36200 Vigo, Spain. Telephone: +34 986 813533; fax: +34 986 812401; e-mail: maxose@uvigo.es.

Endnotes

1 The authors are all Senior Lecturers in the Environmental and Natural Resources Economics (ERENEA) Research Group, Department of Applied Economics, University of Vigo, Spain.

2 Data sourced from http://www.turgalicia.es (accessed in November 2004), Consellería de Cultura, Comunicación Social e Turismo (2004) and Exceltur (2003).

3 Data sourced from the website of the Instituto de Estudios Turísticos (Institute of Tourism Studies), http://www.iet.tourspain.es (accessed in November 2004).

4 There are 1,599 establishments (hotels, campsites, inns and rural tourism) offering nearly 85,000 lodgings, according to Turgalicia, http://www.turgalicia.es (accessed in November 2004).

5 The number of non-residents have changed from +9.2 per cent above the Spanish mean in 2002 to –7.5 per cent in 2003, with a bigger decrease in uses of excursionists (–20 per cent) (http://www.iet.tourspain.es, accessed in November 2004).

6 Executive committee of the IOPC Fund of 11 and 19 February 2004.

7 Spanish rather than Galician households were used because the volunteers' reaction, arriving in Galicia from all over Spain, is a better indicator of the extent of non-use values.

8 This was the directive on 'environmental liability with regard to the prevention and remedying of environmental damage' (Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004).

References

Arrow, K. et al. (1993) 'Report on the NOAA panel on contingent valuation'. *Federal Register.* 58. pp. 4601–4614.

Assemblée Nationale (2000) *Rapport Fait au Nom de la Commission d'Enquête sur la Securité du Transport Maritime des Produits Dangereux ou Pollutants*. 11ª Législature. 5 July. Assemblée Nationale, Paris.

Bonnieux, F., P. Daucé and P. Rainelli (1980) *Impacts Socio-Economiques de la Marée Noire Provenant de l'Amoco Cadiz*. INRA (Institut national de la recherche agronomique)–UVLOE, Rennes.

Bonnieux, F. and P. Rainelli (1991) *Catastrophe Ecologique et Dommages Economiques: Problèmes d'Evaluation à Partir de l'Amoco Cadiz*. Institut national de la recherche agronomique, Paris.

Bonnieux, F. and P. Rainelli (1993) *Learning From the Amoco Cadiz Oil Spill: Damage Valuation and Court's Ruling*. Institut national de la recherche agronomique, Rennes.

Bonnieux, F. and P. Rainelli (2004) 'Cost recreation and amenities: the Erika spill perspectives'. In A. Prada and M.X. Vázquez (eds.) *Economic, Social and Environmental Effects of the Prestige Oil Spill*. Consello da Cultura Galega, Santiago de Compostela. pp. 139–186.

Cámaras de Galicia (2003) *Informe Sobre los Sectores Afectados por el Prestige: Problemas Empresariales y Propuestas de Actuación*. Cámaras de Galicia, Santiago de Compostela.

Carson, R.T. et al. (1992) *Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez*. Attorney General's Office, State of Alaska, Juneau.

Carson, R.T. et al. (1996) *The Value of Preventing Oil Spill Injuries to Natural Resources Along California's Central Coast*. Natural Resource Damage Assessment Inc., San Diego.

Carson, R.T. et al. (2003) 'Contingent valuation and lost passive use: damages from the Exxon Valdez oil spill'. *Environmental and Resource Economics*. 25(3). pp. 257–286.

Carson, R.T., N.T. Flores and N.F. Meade (2001) 'Contingent valuation: controversies and evidence'. *Environmental and Resource Economics*. 19(2). pp. 173–210.

CES (Consejo Económico y Social) de España (2003) *Memoria Socioeconómica de España 2002*. CES de España, Madrid.

CESRPL (Conseil Économique et Social Régional des Pays de la Loire) (2000) *Les Conséquences Economiques et Environnementales de la Marée Noire*. CESRPL, Nantes.

Cohen, M.J. (1995) 'Technological disasters and natural resource damage assessment: an evaluation of the Exxon Valdez oil spill'. *Land Economics*. 71(1). pp. 65–82.

Collins, A., M. Stapleton and D. Whitmarsh (1998) 'Fishery–pollution interactions: a modelling approach to explore the nature and incidence of economic damages'. *Marine Pollution Bulletin*. 36(3). pp. 211–221.

Consellería de Cultura, Comunicación Social e Turismo (CCCST) (2004) *Afluencia Turística a Galicia Año 2003*. CCCST, Santiago de Compostela.

European Commission (2000) *Sobre la Seguridad Marítima del Transporte de Petróleo*. COM (2000) 142 final/2. European Commission, Brussels.

European Commission (2001) *Information on the CFP (Community Fisheries Policy)*. European Community Official Publications Office, Luxemburg.

Exceltur (2003) *Perspectivas Turísticas*. Report No. 4. Analistas Financieros Internacionales, Madrid.

Grigalunas, T.A. et al. (1986) 'Estimating the cost of oil spills: lessons from the Amoco Cadiz incident'. *Marine Resource Economics*. 2(3). pp. 239–262.

Grigalunas, T. and J.J. Opaluch (1993) 'Non-use value in natural resource damage assessments: the Nestucca oil spill'. *Proceedings of the 1993 International Oil Spill Conference*. 29 March–1 April. Washington, DC. pp. 689–695.

Grigalunas, T.A., J.J. Opaluch, J. Diamantides and M. Mazzotta (1998) 'Liability for oil spill damages: issues, methods and examples'. *Coastal Management*. 26(2). pp. 61–77.

Grigalunas, T.A., J.J. Opaluch, M. Luo (2001) 'The economic costs to fisheries from marine sediment disposal: case study of Providence, RI, USA'. *Ecological Economics*. 38. pp. 47–58.

Hanemann, W.M. and I.E. Strand (1993) 'Natural resource damage assessment: economic implications for fisheries management'. *American Journal of Agricultural Economics*. 75(5). pp. 1188–1193.

Hausmann, J.A. (ed.) (1993) *Contingent Valuation: A Critical Assessment*. North-Holland, Amsterdam.

Hay, J. and O. Thébaud (2003) 'Evaluation économique et indemnisation des dommages causés par les marées noires: enseignement tirés du cas de l'Amoco Cadiz'. *Economie Appliquée*. 15(4). pp. 159–195.

Instituto Galego de Estatística (2001) *Contas Económicas. Serie 1995–99*. Instituto Galego de Estatística, Santiago de Compostela.

Instituto Nacional de Estadística (2001). *2001 Census*. Instituto Nacional de Estadística, Madrid. http://www.ine.es (accessed in June 2003)

Mitchell, R.C. and R.T. Carson (1989) *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Resources for the Future, Washington, DC.

Prada, A. (ed.) (2001) *Valoración Económica del Patrimonio Natural*. Instituto de Estudios Económicos–Fundación Pedro Barrié de la Maza, A Coruña.

Varela, M. and A. Prada (2004) 'Valoración de daños sobre los usos del patrimonio natural afectado por los vertidos del Prestige'. *Economistas*. 100. pp. 286–291.