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ANALYSIS

Estimated costs and admissible claims linked to the *Prestige* oil spill

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ABSTRACT

The current case study presents an evaluation of the societal costs caused by the *Prestige* oil spill. We conclude that the economic magnitude of the catastrophe caused by the *Prestige* oil spill is rather significant. Short-term losses in all affected economic sectors, cleaning and recovery costs, and all environmental losses accountable at this point, add to a lower bound estimate of €770.58 million (prices in 2001 currency), excluding all other financial and future possible losses. Such important losses justify future studies that assess potential costs and benefits derived from the application of preventive measures and other contingency plans.

1. Introduction

Due to the frequency of large accidental oil spills, literature illustrating the economic costs and social impacts of such incidents is necessary. In spite of the existence of previous studies (Grigalunas et al., 1986; Moore et al., 1998; among others), there is still a need to better understand the magnitude and importance of previous catastrophic oil spills around the world. The present study contributes to the prior literature in two important ways: a) it presents the economic costs associated with one of the most recent and largest oil spills in history—the *Prestige* oil spill; and b) it introduces the valuation of other dimensions that have not been previously explored, such as the effects of the fishing bans on the canning industries and the opportunity costs of the labor force of volunteers. These, among other factors surrounding the unique nature of the *Prestige* oil spill, make this study relevant in understanding the problems and limitations currently faced by environmental economists when valuing large environmental disasters.

Valuation of economic costs is important for multiple reasons. First, it may provide ex-post answers related to the adequate amount of compensation when liability issues are at stake. Liability rules aim to compensate injured parties for oil spill damages. As previously indicated in the literature, liability can be an important incentive-based instrument for preventing spills and a sustainable approach for restoring coastal resources (Grigalunas et al., 1998). However, economic damage assessments may also be used as an important decision-making tool when assessing the optimal level of protection that should be employed in marine safety in order to avoid similar disasters in the future.

This paper is divided into the following sections: first, it presents a description of the accident; secondly, the losses incurred by each productive sector are presented as well as the assumptions made when computing them; finally, the total costs are computed adding up the total commercial, cleaning, recovery, and environmental losses. The last section presents the caveats and limitations of the current research, and

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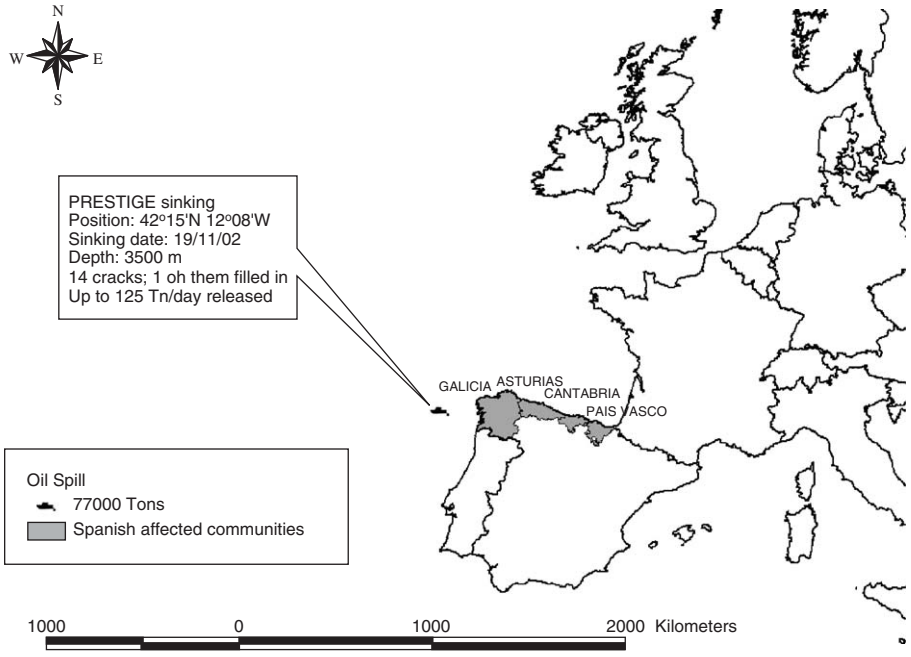


Map 1 – *Prestige* sinking in Spanish waters.

concludes with some recommendations concerning data collection issues that may be helpful when assessing the impacts of future comparable oil spills.

2. The accident

On November 13, 2002, the single-hull, 26 year-old oil tanker, *Prestige*, suffered a serious accident just 46 km off the Finisterra Cape, in the Northwest of Galicia (Spain). The *Prestige* possessed a complicated parentage. It was owned by a Liberian company, registered in the Bahamas, and was operated by a Greek captain with a Filipino and Greek crew. It carried about 77,000 metric tons (MT) of heavy low-quality oil. Six days after the accident, and after traveling without a clear direction outside the Atlantic coast of Galicia, the *Prestige* sank 222 km away from the Cies Islands on November 19, 2002, after splitting in two during a storm (See Map 1).

On its way to the bottom of the sea, the tanker spilled more than 60,000 MT of oil, polluting more than 1300 km of coastline. The *Prestige* oil spill was a very serious environmental catastrophe. It began in November 2002 and lasted for about 4 months, affecting the coasts of Northern Portugal, Northern Spain and Southern France. However, most of the oil impacted the continental shelf and coastal zones of Galicia (region in NW Spain).

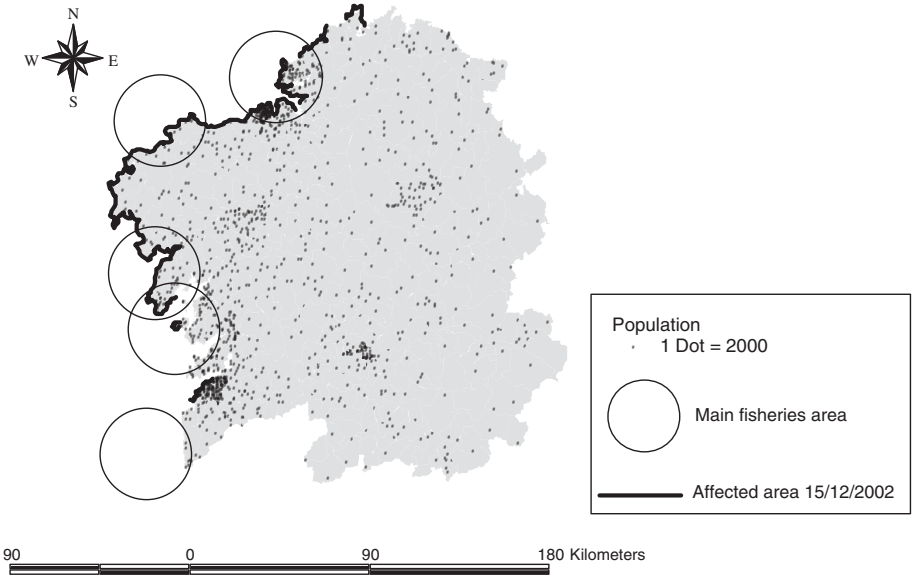
Table 1 – Previous spills in Galicia (NW Spain)

Ship's name	Quantity (metric tons)	Year	Content
Urquiola	101,000	1976	Oil
Aegean Sea	80,000	1992	Oil
Prestige	64,000	2002	Oil–fuel
Andros Patria	16,000	1978	Oil
Polycommander	15,000	1970	Pesticides
Erkowitz	200 barrels	1970	Pesticides
Casón	1100	1987	Chemical products

Although Galicia is well-known for its dangerous waters, in which several oil spills have occurred before (See Table 1), the *Prestige* oil spill was the most serious environmental accident ever suffered in Spanish waters. The proximity of Galicia to one of the world's busiest shipping routes, along with the presence of a refinery located in one of its largest ports (A Coruña), contribute to a high frequency of spills in the region. In total, Galicia has suffered five out of the eleven major oil spills in Europe in the last three decades. Furthermore, during the last 30 years, the entire volume of oil spilled in these waters constituted 10% of the total of large spills in the world. Unfortunately, due to the lack of detailed studies, the importance of previous accidents and their respective effects on local eco-systems and on the local economy have not been well documented. The only existing study that we are aware of was conducted by García Negro et al. (1994), who estimated the commercial fishery losses caused to Galician society by the Aegean Sea oil spill.[1]

The Galician coast, which was the most heavily affected by the *Prestige* oil spill, supports a large number of human settlements that are economically and culturally linked to the sea. At present, there are over 80 communities whose economies depend directly on catching fish and extracting shellfish resources. These locales range from large cities (Vigo, A Coruña, Ferrol, etc) to mid-sized towns (Muxía, Malpica, Ribadeo, etc) or small villages that often times have below 200 inhabitants. (See Map 2). The spill affected multiple protected

[1] During the review process of this paper, we found a new recent document published by CES-Galicia during the summer 2005, illustrating some of the costs caused by the *Prestige* in Galicia. The reference is: "Consideración sobre os efectos dos vertidos do fuel do buque *Prestige*." Document coordinated by: M. Varela and A. Prado. Edited by CES Galicia, Report number 01/05.



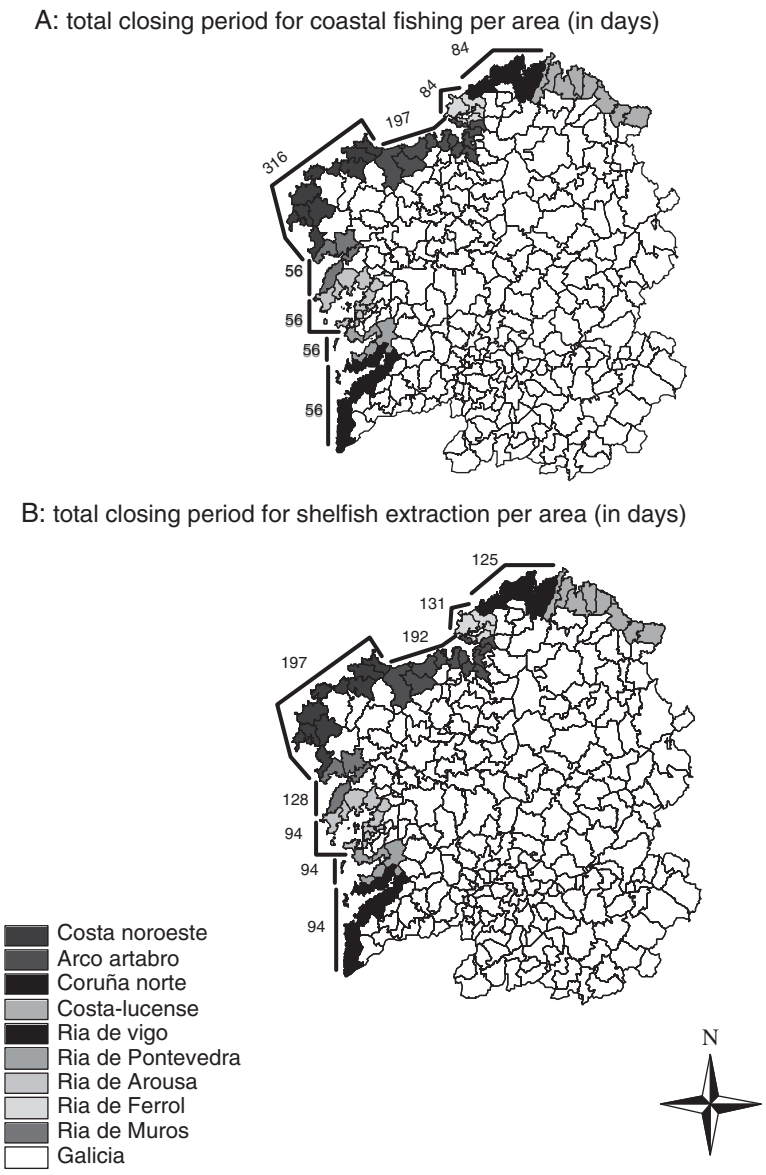
Map 2 – Main fishery areas and population density in Galicia.

areas and natural parks along the entire North Coast of Spain, including areas of special interest in the Autonomous Communities of Galicia, Asturias, Cantabria, and Basque Country. Among the places characterized by their natural beauty, the oil affected the National Park of Atlantic Islands, the protected wetlands and marshes in Corrubedo and in Ria Eo (all in Galicia), as well as the Natural reservoir of Santoña and Noja (Cantabria), and the protected wetlands of Ria de Mundaka–Guernika (Basque Country). These are some of the richest ornithological areas in Europe (Chas-Amil et al., 2004).

The oil spill from the *Prestige* arrived at the Spanish coast in three large "black waves", contributing to the extended agony of all affected individuals. The first large wave arrived at the Galician coast on November 16, 2002, and at the time the regional authorities of Galicia issued a prohibition for inshore fishing as well as shellfish extraction (fishing and shellfish ban) in the affected area. The lack of cleanup equipment and qualified personnel made articulating a quick and effective response difficult across such a large affected area. While the oil was piling up on seashores and beaches, the second wave of oil arrived on November 20, 2002, being the worst in magnitude (with 30 km in length according to satellite images). Almost the entire Galician littoral was closed for fishing and shellfish extraction, and in most cases, the affected areas would not be re-opened until a few months later (See Map 3). When the *Prestige* sank, it was estimated that it took around 50,000 MT of its cargo of heavy oil down to the seabed. However, posterior estimations showed that only 11,000 MT remained inside the tanker, while the rest was spilled into the surrounding waters. The third oil wave arrived at the coasts on December 19, 2002, after the tanker sank. However, until February 1, 2003, the *Prestige* continued to leak oil from its tanks while on the seabed, creating multiple smaller spills that arrived at the seashores. The cleanup operation continued for many months, although by summer time 2003 most of the affected beaches were cleaned.

In December 2004, after all cleaning operations were completed on the coast, a total of 97,000 MT of waste emanating from the *Prestige* had been collected along the coast of Galicia, of which 78,000 MT were solid materials, and 19,000 MT were oiled waters collected by the cleaning ships. In addition, after a highly sophisticated operation took place during the summer months of 2004, the Spanish oil company "Repsol" extracted the remaining oil inside the tanker, collecting about 11,000 MT more.

Although fingers are pointing in many directions with respect to legal responsibility, who is responsible and how much has to be paid are two very tough questions to answer. In this sense, the international regulatory system limits the amount and the scope of the compensation received by affected parties. Currently, the overall international compensation regime for damages caused by spills of persistent oil from laden tankers is regulated by the 1992 Civil Liability Compensation (CLC) Fund, which entered into force in 1996. As in the case of the previous conventions, the tanker's owner and insurer are liable for payment of compensation, as well as oil receivers in countries that are party to the 1992 Fund Convention. In October 2000, the contracting states to the 1992 CLC Fund approved a proposal to increase by about 50% (to an estimated total of $260 million) the amount of compensation available under the terms of the Convention. This Supplementary Fund, which entered into force November 1, 2003 (after the *Prestige* oil spill), was reinforced by an additional Supplementary Compensation Fund in March 2005 that increased the international regime for compensation of victims of oil pollution from oil tankers. The Supplementary Fund does not replace the existing 1992 Fund, but does make available additional compensation to victims in the States that acceded to the Protocol. In total, about $1159 million are now available for compensation for spills occurring in States that are Members of the Supplementary Fund. This Supplementary Fund will only cover accidents occurring after March 3, 2005. However, the maximum payable amount by the 1992 Fund, with respect to an incident occurring before November 1, 2003, is $199 million. In the meantime, other countries, which have not ratified the international compensation conventions, will have their own domestic legislation for



Map 3 – Length of fishing and shellfish extraction bans. A: total closing period for coastal fishing per area (in days). B: total closing period for shellfish extraction per area (in days).

compensating those affected by oil spills from tankers, such as the Oil Pollution Act in the US.

As Mason (2003) points out, in spite of the incremental increases in compensation, concerns still exist that environmental compensation claims are not allowed under the 1992 Fund. Thus, environmental quantifiable economic loss assessments have been opposed by the International Oil Pollution Compensation (IOPC) Fund on the basis of regulation No. 3. This regulation asserts that "the statement of compensation to be paid by the International Oil Pollution Compensation Fund is not to be made on the basis of an abstract quantification of damage in accordance with theoretical models." This excludes very important types of losses that are not recoverable, such as acquisition costs of "equivalent" ecosystem services in replacing severely damaged areas.

The present study covers a quantification of the short-term damages, including to the extent that the data allow it, environmental damages that are not recoverable under the 1992 CLC/IOPC rules. We attempted to quantify these damages as they are losses that society faces in terms of utility reductions when any environmental accident occurs. In order to approximate the total social damages caused, we analyze the effects of the *Prestige* oil spill in each of the affected productive sectors: the rich commercial fisheries and shellfish sectors, the canning and processing fish and shellfish industries, mussel production, and the tourism sector. When data were also made available for the rest of the affected Spanish regions (Asturias, Cantabria and Basque Country), we calculated the total cost of the *Prestige* oil spill for all of Spain. A similar methodology used in assessing economic costs was employed by researchers determining the impact of previous oil spills, such as the *Amaco Cadiz* (Grigalunas et al., 1986), the *Sea Empress* (Moore et al., 1998), and the *Exxon Valdez* (see Preston et al., 1990; Brown, 1992). Potential applications of other methodologies such as the Habitat Equivalence Analysis (HEA), the Resource Equivalence Analysis (REA), or Restoration

Table 2 – Total landings of inshore fishing and shellfish captures and their respective ex-vessel value in the northwest coast area during 2002–2003 (36 species included)

	Quantities (kg)			Value 2003 (€)		
	Before *Prestige* 11/01–10/02	After *Prestige* 11/02–10/03	% Difference	Before *Prestige* 11/01–10/02	After *Prestige* 11/02–10/03	% Difference
November	187,599	96,660	−48.48%	800,302	401.406	−49.84%
December	201,685	0	−100.00%	1,055,715	0	−100.00%
January	250,091	0	−100.00%	746,808	0	−100.00%
February	132,358	2,500	−98.11%	512,187	1,250	−99.76%
March	162,149	38,720	−76.12%	622,255	20,235	−96.75%
April	1,003,200	6,200	−99.38%	963,969	3,720	−99.61%
May	778,754	921	−99.88%	974,512	2,411	−99.75%
June	576,994	85,038	−85.26%	908,786	104,269	−88.53%
July	417,206	786,627	88.55%	1,077,595	941,081	−12.67%
August	815,818	726,687	−10.93%	1,833,325	899,253	−50.95%
September	639,549	1,059,644	65.69%	1,086,402	1,137,645	4.72%
October	506,587	n.a.	n.a.	1,031,570	n.a.	n.a.
Total	5,671,990	2,802,997	−50.58%	11,613,425	3,511,270	−69.77%

Source: Data gathered from Xunta de Galicia (a), access at: www.pescadegalicia.org.

Based Analysis (RBA) (as in McCay et al. 2004; Dunford, Ginn and Desvousges (2004) and Mazzotta et al. (1994)) would provide estimates of costs needed to restore equivalent resources or the adequate amount of compensation based on bio-economic models. However, the difficulties found in some cases to properly define the baseline scenario, would call into question their accuracy in the present case study.

3. Losses in commercial fisheries and shellfish

As Cohen (1995) notes, the valuation of commercial fisheries may be complicated due to the following factors: a) there is widespread controversy among biologists regarding the morbidity effects of carbon-based toxicity on individual species of fish; b) the effects of the oil spill depends largely on the mobility of fish populations and, consequently the possibility of escaping toxicity; and c) the unknown effects of oil spills in the reproductive cycles of fishes and shellfish. In addition to the well-documented concerns found in previous valuation studies, the multi-gear and multi-species characteristics of Galician commercial fisheries present an added complexity; it is possible to list more than 50 species that are harvested for commercial purposes (Freire and García-Allut, 2000). Due to this rich biodiversity, statistically reliable data are only available for the species with the highest commercial values. In previous oil spills, such as the *Exxon Valdez* oil spill, traditional fisheries were more homogenous and most of the species had a recorded commercial worth, hence facilitating their valuation (Cohen, 1995). In Galicia, the variety and richness of the local fisheries is such that valuation of total losses is extremely difficult, if not impossible to fully calculate.

From an economic view point, the most important species within the Galician coast are the crustaceans (the velvet swimming crab, spider crab, prawns and goose barnacle); the bivalve mollusks (several species of clams, razor clams, scallops, and cockles); and the cephalopods (octopus, cuttlefish and squid). In the rest of the Cantabric Coast the most predominant species, from an economic perspective, are the hake, blue fin tuna and anchovies. According to the statistics released by the fisheries Department in Asturias, the species with the highest commercial value in that region are the hake, blue fin tuna, monkfish, and the blue whiting, followed by crustaceans and mollusk. In Cantabria, the most popular species are blue fin tuna, anchovies, Atlantic mackerel, and monkfish. Finally, in the Basque Country, the species with the highest commercial value are the blue fin tuna, anchovy, hake, and horse mackerel.

In order to approximate the losses caused by the *Prestige* in Galician fisheries, we collected detailed data on 36 species from 1998 to 2004.[2] These species account for 80% of the total ex-vessel volume and value commercialized in Galician fishing ports. For the rest of the Cantabric region we collected data on the most important species, as well as on the total volumes of landing and associated revenues in the fishing and shellfish extracting sectors. Although it would be more convenient to use data on stocks and catching efforts, we use total landings and their respective economic ex-vessel values to approximate the impact of the *Prestige* oil spill over the fisheries in an indirect way. Landings may not properly reflect the size of the fish stock. However, based on the fact that available geographical statistics of biomass levels do not exactly correspond with the affected area, we prefer analyzing actual fish landings to avoid large measurement errors.

The collected statistics demonstrate that inshore fishing and shellfish were heavily affected by the spill. Table 2 presents the reductions in landings on the Northwest Coast of Galicia around Finisterre Cape (the most affected area). Landings of inshore fishing and shellfish in this area were practically nonexistent within the first six months after the oil spill. This part of the Northwest Coast of Galicia is characterized by the predominance of artisan inshore fisheries rich in demersal fish species, crustaceans, and cephalopods. However, for all of Galicia, off-shore fishing accounts for about 50% of the total captures and ex-vessel economic values, and hence the effect of the *Prestige* oil spill was much acute on

[2] The relatively short time span of the statistics does not allow to properly forecast the estimated catch levels as it was done by Grigalunas et al. (1986).

Table 3 – Total landings of all fishing and shellfish captures and their corresponding ex-vessel value in Galicia during 2002–2003 (36 species included)

	Quantities (kg)			Value 2003 (€)		
	Before *Prestige* 11/01–10/02	After *Prestige* 11/02–10/03	% Difference	Before *Prestige* 11/01–10/02	After *Prestige* 11/02–10/03	% Difference
November	12,349,114	8,995,320	−27.16%	30,916,810	27,540,750	−10.92%
December	10,754,222	5,699,191	−47.01%	36,675,752	21,205,564	−42.18%
January	9,083,334	4,894,248	−46.12%	24,989,145	16,802,860	−32.76%
February	9,979,099	7,396,512	−25.88%	24,043,029	18,909,273	−21.35%
March	11,459,129	9,738,649	−15.01%	24,682,839	24,328,426	−1.44%
April	13,647,478	11,038,192	−19.12%	28,201,679	25,074,146	−11.09%
May	11,636,264	9,837,437	−15.46%	27,563,762	27,398,916	−0.60%
June	10,838,146	10,201,391	−5.88%	27,062,495	25,679,626	−5.11%
July	12,185,777	13,075,804	7.30%	33,015,182	31,902,687	−3.37%
August	11,182,449	11,205,916	0.21%	32,262,681	28,886,784	−10.46%
September	11,606,465	14,082,972	21.34%	28,152,376	33,989,311	20.73%
October	11,723,186	13,249,551	13.02%	30,428,855	34,278,236	12.65%
Total	136,444,663	119,415,183	−12.48%	347,994,605	315,996,579	−9.19%

Source: Data gathered from Xunta de Galicia (a), Database PescaGalicia (www.pescadegalicia.org).

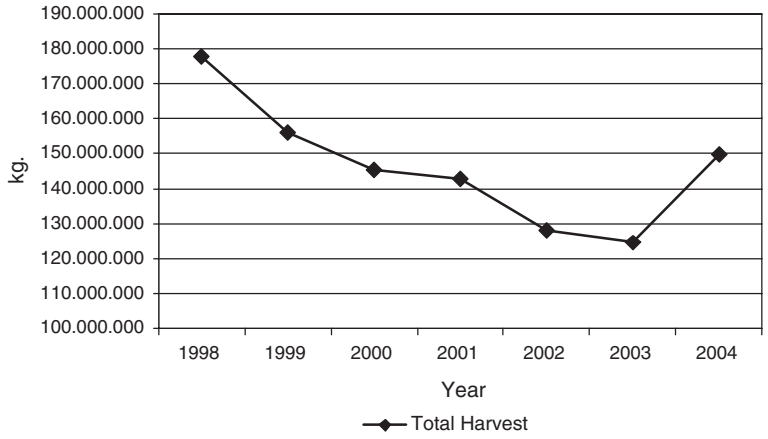
those local coastal communities dependent upon inshore fishing and shellfish extraction.

Tables 3 and 4 show the reduction of landings in 2003 and posterior recovery in 2004 for all fish and shellfish species (including inshore, offshore fishing, and shellfish). Twenty-three out of the 36 analyzed species decreased their landings from 2002–2003 with respect to the previous year (See Table 4). As expected, the sedentary species were the most affected. Biologists are especially worried about the stocks of species that suffered drastic reductions in landings, among them: sea urchin (with a reduction in landings of −95.1%), clam-banned carpet shell, (−50.1%), sword-razor shell (−44.04%), scallop (−42.5%), clam-pulled carpet shell (−27.9), short necked clam (−21.4%), razor clam (−18.5%) and barnacle (−15.5%). Reductions in landings were also important for other fish species, including: horse mackerel (−34.3%), pouting (−27.1%), sea bass (−20.7%), sole (−16.3%), sardine (−12.8%), hake (−9.6%), blue whiting (−4.4%), and monkfish (−2.8%).

Table 4 – Evolution of total landings (in kilograms) in Galicia during the period 1998–2004 (2004 contains only first 9 months available)

Name	1998	1999	2000	2001	2002	2003	2004	Total period
Clam, pulled carpet shell	1,547,046	1,611,590	1,169,430	853,798	886,286	689,764	672,467	7,430,381
Clam, banned carpet shell	145,352	120,009	303,914	276,048	298,467	157,397	128,689	1,429,876
Reló	909,670	1,005,663	738,621	968,041	1,387,370	1,000,935	1,117,788	7,128,090
Clam, grooved carpet shell	535,085	529,181	522,545	420,322	511,596	458,987	477,385	3,455,099
Common cockle	1,751,516	2,059,311	1,847,607	736,484	2,271,527	1,534,963	2,121,842	12,323,249
Short necked clam	464,993	483,065	511,681	220,550	433,884	432,994	495,137	3,042,304
Razor clam	81,460	81,799	98,854	104,089	87,960	59,087	97,318	610,567
Sword–razor shell	23,909	27,535	15,892	14,939	16,446	9,114	3,630	111,464
Scalop	27,575	1,265	60,610	830	84,934	55,212	141,890	372,316
Goose barnacle	280,191	299,020	336,817	347,062	308,116	212,121	323,254	2,106,581
Spider crab	62,012	78,482	76,809	65,783	71,781	82,818	107,776	545,460
Velvet swimming crab	46,590	38,927	44,780	36,453	36,876	43,955	45,119	292,699
Octopus	2,644,202	2,052,650	1,560,410	1,424,947	1,543,379	1,547,879	2,042,107	12,815,574
Cuttlefish	359,542	320,761	196,795	171,002	214,590	210,480	324,977	1,798,146
Pouting	949,858	1,138,671	2,063,360	1,064,250	684,351	597,463	724,722	7,222,676
Bass	115,550	112,224	138,958	99,185	81,881	53,480	134,598	735,875
White seabream	52,622	43,935	56,917	45,782	53,721	47,069	52,883	352,929
Common sole	104,402	132,219	145,371	75,130	62,843	45,680	77,855	643,499
Turbot	106,863	118,806	92,685	96,280	75,547	51,700	60,204	602,085
Sea urchin	388,874	453,924	424,945	301,678	543,232	17,744	582,763	2,713,159
Sardine	6,952,367	4,925,190	4,798,049	11,395,240	8,861,688	9,364,812	14,478,081	60,775,426
Atlantic mackerel	9,969,022	7,429,863	7,247,544	6,345,995	9,770,801	7,096,324	9,102,997	56,962,546
Blue whiting	16,507,907	16,853,811	15,953,506	12,820,836	11,696,612	7,588,529	10,703,209	92,124,408
Horse mackerel	31,715,142	21,978,376	20,771,842	18,699,380	15,281,577	12,562,294	17,316,100	138,324,711
European hake	12,722,073	15,535,979	16,557,583	10,401,032	10,015,257	9,746,113	12,192,315	87,170,351
Black belied angler	3,262,230	3,203,797	2,346,624	1,783,798	2,555,377	2,809,859	2,856,063	18,817,747
Norway lobster	929,914	986,886	599,078	493,295	554,007	553,150	808,703	4,925,033
Total	92,655,967	81,622,938	78,681,225	69,262,225	68,390,106	57,029,924	77,189,870	524,832,254
Total Galicia	136,357,278	119,803,44	116,003,98	107,063,350	101,618,141	91,471,121	113,772,289	786,089,609

Source: Data gathered from Xunta de Galicia (a), Databse PescaGalicia (www,pescadegalicia,org).



Graph 1 – Evolution of total landings of fish and shellfish captures (in kilograms) in Galician Ports. Source: Data obtained from www.pescagalicia.com, Xunta de Galicia (2004a).

After the reopening of fishing activities, landing volumes increased for all species in 2004. Some critics point to the fact that the fishing and shellfish extraction bans in Galicia (with a length of two to eight months) were brief in duration, and that the opening of banned areas may carry some negative effects in the long run over the stocks that have been seriously damaged. This is due to the fact that after the lifting of the bans, catching efforts were more concentrated in some fisheries than it otherwise would be. In the case of the *Prestige* oil spill, the fishing bans lasted from less than eleven months in the most affected areas to about two months in the South of Galicia (less affected). Bans were also applied in the rest of the Cantabric coast and in South France, although for shorter lengths, with most restrictions lifted in January 2003. In Galicia, the shellfish bans were even shorter than those applied to inshore fishing, lasting from six and a half months in the most affected areas to less than two months in South Galicia (See Map 3). As a comparison, after other oil spills such as the *Braer* (Shetland Islands, 1993) crustaceans (except lobster) were allowed to be fished after 22 months of closure, mollusks (except mussels) after 25 months, and lobsters and mussels after seven years. Following the *Erika* spill off Brittany in 1999, closure lasted from two to eighteen months.

After putting aside other political considerations that may contribute to the length of fishing and shellfish bans, the landing statistics indicate that in the short-run the consequences of the spill for the fishing sector were serious. However, a longer time span would provide more detailed information. Unfortunately, the recovery of catch levels in 2004 does not necessary imply a diminishing effect of the oil spill on the fish and shellfish populations. Rather, it may point to the fact that stocks of many species were consistently overharvested, as well as previously damaged by intensive fishing and other past spills (Freire and Labarta, 2003).

When studying the evolution of all registered landings between 2000–2004 for the 36 species analyzed in Galicia, we observe a serious reduction in seven species during this period: bream (−70.7%), clam-banned carpet shell (−55.7%), clock clam (−21.1%), short necked clam (11.3%), blue whiting (−1.8%), and turbot (−1.1%). Nevertheless, it is difficult to isolate the effect of the *Prestige* oil spill from the previous declining trend. A graphical representation of the total volume of landings of fish and shellfish in Galicia (See Graph 1) between 1998 and 2004 shows a decreasing trend, even prior to the *Prestige* oil spill.

As noted earlier, short-term effects in captures after the spill were rather important and immediate. When comparing landing volumes in 2002 and 2003 with respect to those in 2001 (the year before the spill), losses in the fish and shellfish sectors in Galicia total €38.40 million in 2002 and €41.00 in 2003.[3] Table 5 presents a summary of the overall trend of the landings and their respective economic value in all affected Spanish regions. As the table shows, the impact of the *Prestige* oil spill differs among the affected areas, the most serious impacts located in Galician fisheries, followed by the damage caused in Basque Country fisheries (with associated losses of €39.10 million during the period 2003–2002), and Cantabrian fisheries (with losses of €25.78 million during the same period). In the Basque Country, the most affected fish specie was the anchovy, changing from 19 MT of landings in 2001 to 2.78 MT in 2003, although it is not possible to differentiate the marginal contribution of the *Prestige* oil spill from other factors. Other specie seriously affected was the blue fin tuna. However, the real consequences of the *Prestige* oil spill over fish stocks and biomass are not easy to measure in the short run, and further analysis will be needed in the future.

To net out the possible savings due to the reductions of inputs usage (labor, oil, nets, etc) during the fishing bans, we first calculated the differences of expenditures in the total inputs used by the entire fishing and shellfish sector in Galicia in 2002 with respect to 2001 (Galician Institute of Statistics-Instituto Galego de Estadística, (IGE)). According to these public statistics, input usage in Galician coastal fishing and shellfish decreased by €2.22 million in 2002, with respect to 2001. Further, salary savings of fishermen and other associated labor costs saved during roughly 45 days of fishing bans in 2002

[3] However, other studies presented by the associations of fishermen indicate that real losses caused by the *Prestige* may have been underreported by the administration, adding up to a total of €72 million between 2002 and 2003 only. Nevertheless, in this analysis we employ official data, given that historical series are not available in other studies.

Table 5 – Evolution of landings and value of sales in the affected northern coast of Spain

	Galicia		Asturias		Cantabria		Basque Country	
Total	€ (in 1000) (real prices 2001)	Quantity (MT)	€ (in 1000) (real prices 2001)	Quantity (MT)	€ (in 1000) (real prices 2001)	Quantity (MT)	€ (in 1000) (real prices 2001)	Quantity (MT)
2001	354,890,00	128,035	36,896.7341	15,806	32,577	28,607.46	91,109.96	69,982.18
2002	316,488.462	124,665	37,428.0096	18,198	27,402	25,250.36	76,889.82	51,062.12
2003	313,887.535	151,246	38,553.2615	18,288	18,020	10,738.56	66,225.46	37,627.25
2004	353,494.555	109,922	41,333.9111	16,798	26,526	9303.07		

Data gathered from Xunta de Galicia (a), Department of Rural Areas and Fisheries. Government of Asturias. Department of Livestock, Agriculture and Fisheries. Government of Cantabria, and Department of Agriculture, Fisheries and Food. Basque Country, SEAS database.

amount to a total of €6.53 million. Magnitudes for the year 2003 are not yet published, although we could expect that savings of labor costs would be highly correlated with the length of the established extraction bans. Hence, if we assume a saving of another 45 days of effort for all fishermen, then the reduction of labor costs within the entire Galician fishing sector would amount to €6.69 million (accounting for a 2.5% inflation rate), while the estimated savings in other inputs (if proportional to that reduction in 2002) would be about €2.27 million more. Thus, the net total loss for the entire fishery and shellfish extracting sector during 2002–2003–2004 could be approximated as the accumulative loss of the value of landings minus the corresponding savings (during 2002 and 2003), adding up to a total of €63.08 million for Galicia. Employing the same methodology to net out savings and using the data provided by the different regional fishery departments, the net losses in the entire Spanish fishing sector were calculated at €112.66 million for the period 2002–2003–2004.

In addition to these fishing commercial losses there exist other extra-market damages that should also be considered, among them, those resulting from the destruction of biota (phytoplankton, zooplankton, and other multiple microorganisms), as well as algae used to feed many fish populations. A study conducted by Valdés et al. (2003) indicated that there were no differences in the amount of biomass of phytoplankton and zooplankton found in the Galician coast after the *Prestige* oil spill, not even in the composition and biological cycles of zooplankton that could be understood as an effect of the *Prestige* oil spill. Based on these scientific findings, we concluded that at this stage, it was no scientific evidence to include losses due to reductions of biota in our analysis.

4. Losses in mussel farming

Mussel farming is one of the most important shellfish productions in Galicia. Mussel farming occurs in the estuaries of the rivers, mainly in South Galicia. Galicia produces about 99% of all mussel harvested in Spain. In the year 2000, the total production of mussel amounted to 259,131 MT. Mussels are commercialized and exported directly by three organizations of producers. The largest organization of producers is OPMEGA, which is comprised of 1430 producers that own about 1860 mussel beds. This accounts for the 60% of the total production in Galicia. OPMEGA sells three types of mussel qualities: mussel for the fresh market (with a quality grade of "average" or "special"), and industrial mussel (usually of smaller size). The industrial quality mussel is the cheapest, and is sold to canning factories and to food processing industries.

Although mussel beds were not directly soiled, news surrounding the spill, and other food safety concerns caused a reduction of prices in the fresh markets during 2003. Consequently, in order to avoid financial losses, OPMEGA switched its commercialization and marketing strategies during 2003, pushing sales towards the canning and food processing industry, and reducing the mussels sold to the fresh market. At a first glance (See Table 6), prices went down slightly for the mussels graded as average or industrial quality,

Table 6 – Mussel production from November 2002 to October 2003

	Kilograms transferred between						
	Market shares			Market prices (per kilo)			Total losses (2001)
	Normal	Especial	Industrial	Normal	Especial	Industrial	Total
November	187,385	471,667	−656,052	0.68	1.06	0.51	294,356
December	3,043,876	2,522,245	−5,566,120	0.69	1.06	0.47	2,134,532
January	2,624,813	2,063,839	−4,688,652	0.68	1.06	0.44	1,915,123
February	103,509	871,456	−974,965	0.67	1.06	0.48	525,124
March	−240,662	558,281	−317,62	0.67	1.06	0.41	300,453
April	450,284	−388,068	−62,216	0.68	1.06	0.41	−128,518
May	897,114	−558,734	−338,380	0.68	1.06	0.38	−108,301
June	445,517	−45,394	−400,123	0.67	1.06	0.41	89,771
July	−203,575	−428,231	631,806	0.70	1.06	0.42	−333,933
August	−379,732	−166,881	546,613	0.70	1.06	0.42	−209,77
September	−658,999	290,777	368,222	0.66	1.06	0.43	31,115
October	−2,393,302	−504,798	2,898,100	0.66	1.07	0.49	−705,18
Total	3,876,229	4,686,159	−8,559,388				3,804,772

Source: Data gathered from OPMEGA (2004).

and increased for the mussels graded as special quality. These price movements were mainly driven by the supply side and other market conditions after the spill.

Assuming that changes in the selling strategy were exclusively due to the *Prestige* oil spill, and not to any other market condition, we can account for reductions of 3,876,229 and 4,686,159 kg, respectively, in the mussels supplied to the fresh market of average and special quality, and a gain of 8,559,338 kg in the share of mussel supplied for industrial use. Given the reductions in prices of the normal and industrial qualities, total market losses in the mussel production in the year 2003 amount to €3.804 million. Note however, that this loss does not include other financial losses that mussel farmers may have faced (such as the loss of perceived quality and reputation of their product). Other estimations made by Deloitte and Touche (2004), suggest that total damages to the sector (including image damages, losses of future income, and financial losses associated with current market losses) could add to a total of €7 million. Unfortunately, data on other associations of producers are missing, although if we assume that the rest of the producers not included in OPMEGA were equally affected, then total losses in the mussel sector would amount to €12.83 million.

5. Losses in the canning and fish processing sector

Many of the local canning and fish processing industries, that are heavily dependent on shellfish and coastal fishing, were significantly affected by the fishing and shellfish extraction bans. Consequently, some did not register any production activity (or operated only a few hours per day) until the bans were lifted. This was particularly serious for some of the small firms selling local typical products from Galicia, such as special algae, oysters, and clams.

According to official statistics, in the year 2002, the fishing industrial sector employed a total of 29,200 individuals in catching and extraction activities, and about 15,000 more in the canning, freezing and processing fish and shellfish industries (thus, about 5% of the total working population in Galicia). However, the local canning and processing industry is an important share of the total Spanish sector. In particular, about 45% of the total canning companies in Spain are located in Galicia, accounting for 80% of the total volume of sales in the sector. In estimating the damages caused to the canning and processing industries, until more data are released, we can only approximate the short-term consequences of the extraction bans by employing some assumptions. Based on information published on the main leading economic newspapers, during the year 2003,[4] about 10% of the small fish canning firms entirely closed their operations for a duration of at least 6 months as a consequence of the extraction bans. These small manufacturers were heavily dependent on local supply. However, most of the canning and fish processing firms maintained their regular production rates since they are specialized in the processing of demersal fish species (tuna, mackerel, sardine) which were not as affected as shellfish and other coastal fishing species. Many large manufacturing firms in order to preserve their prior production levels changed the local supply of fish by imports from South America. Therefore, total magnitudes of revenues associated with the fish canning and processing sectors showed that in spite of the *Prestige* oil spill, there is a slow growth in the production volume and associated revenues. Nevertheless, as it was covered by the press and later reported by the association of canning industries (ANFACO, 2004), the smallest firms were heavily affected by the *Prestige* oil spill. Thus, in the absence of a spill, we could have expected an even bigger growth in the fishing and shellfish canning sector. In order to approximate the effect of the *Prestige* oil spill on the smallest firms, we split our dataset (ARDAN, 2004) of fishing and shellfish processing firms in deciles, such that the first decile contains 10% the total firms, which are the smallest operating firms. The evolution of the gross value added (GVA) product (value of output minus value of inputs) in this set of firms indicates that there was a decline of about 8% of the total GVA between 2003–2002 when compared with that of 2002–2001 (See Table 7). This reduction amounts to a total loss of €214,081 during 2003 for this set of small firms. However, this appears a conservative estimate. Based on the performance of previous years, we could have forecasted a large market expansion of these firms, well above the 8% growth in the entire fishing and canning sector during 2003–2002. Assuming that these small firms would have increased at least their GVA by as much as the entire fishing and shellfish processing sector, the estimated losses would amount to €423,681. In addition to these domestic losses, statistics released by ANFACO (2004) demonstrate that exports of fish canning products are decreasing after 2001. Table 8 presents the evolution of fish exports in terms of prices (2001 price levels) and volumes. Given that the Spanish canning and fish processing sector has a GVA of about 15% of the value of the final product, we can estimate that the damages to the fish canning sector by additionally adding €26.35 million to the previous amount (175,688 million of losses in 2002, 2003, and 2004*15%). However, the decline in exports may be attributable to a joint causation of several factors, including among them, the strong performance of the Euro currency in 2004. As such, we should acknowledge that it is difficult to quantify the reduction in exports solely due to

Table 7 – Summary of main indicators of the fish and shellfish canning sector—total Galicia

	10% Smallest companies	Rest	Total sector
Workers 2001	46	8287	8333
Workers 2002	55	8457	8512
Workers 2003	42	9015	9057
Gross value-added 2001	1,526,636	205,804,649	207,331,285
Gross value-added 2002 (in € 2001)	2,619,994	221,380,616	224,000,610
Gross value-added 2003 (in € 2001)	2,405,913	249,218,655	251,624,568

Source: Ardán database, 2004.

[4] It was reported that fishing bans had seriously affected 10% of the firms in the canning sector specialized in local delicatessen products, mussels and clams (Source: Newspaper Cinco Dias, 01/20/2003).

Table 8 – Export trend of fish and shellfish

	Volume in 1000 kg				Value in €1000			
	2001	2002	2003	2004	2001	2002	2003	2004
	MT	MT	MT	MT	In €1000(01)	In €1000(01)	In €1000(01)	In €1000(01)
Sardine	3667	2511	2919	2632	10,548	7554.81	8269.92	7765.88
Tuna fish	81,482	71,911	73,551	70,861	276,558	254,452.88	237,783.51	220,284.94
Mackerel	1458	1280	1101	846	5359	5348.08	4862.23	3662.43
Other fish	13,153	12,653	9285	8795	41,689	40,379.81	32,956.89	28,408.35
Mussels	1371	1305	1300	1427	6017	5787.50	5641.99	5152.45
Other mollusks	11,762	8998	6286	7934	34,230	27,260.58	20,115.28	22,639.75
Rest species	11,508	12,811	13,523	13,448	33,291	35,933.65	36,539.83	36,587.11
Total	124,401	111,469	107,965	105,943	407,692	376,717.31	346,169.63	324,500.91

Source: ANFACO (2004).

the *Prestige* oil spill. Adding these losses suffered by small domestic companies (which satisfied a local demand for exclusive products) as well as the losses suffered in the export markets, the total losses are estimated to amount to €26.77 million (in 2001 prices). However, we consider this again to be a lower bound estimate. In accurately assessing the effects of the oil spill in the fishing and shellfish canning market, one notable obstacle is that the value of the production does not necessarily reflect yearly sales, as the output is storable and can be stocked. Consequently, damages linked to the *Prestige* oil spill may appear after a few years if demand shifts occur.

6. Losses in the tourism sector

Tourism data have been collected from various official sources, including several surveys from the *Institute of Tourism Studies* (Instituto de Estudios Turísticos (IET)). From the IET we employed two surveys, one conducted among domestic visitors (Familitur survey) and a second one among foreigners (Frontur survey). Both sources are complementary although information is not directly comparable. IET collects data on the number of domestic and foreign visitors, average stay, and average expenditures per traveler on a sample of tourists.

As Table 9 shows, the number of total visitors in Galicia decreased considerably right after the *Prestige* oil spill in 2002. A first approximation to the losses in tourism is presented in Table 9. The losses in the tourism sector in Galicia which are linked to reductions of domestic visitors are about 29.31 million in 2002, with respect to the levels in 2001. This sector appears to recover in 2003, although it decreases again in 2004 with respect to the previously achieved levels in 2003. The quick recovery in the number of domestic visitors in 2003, although generally unexpected, may also be partially justified by a solidarity effect towards Galicia shown by other Spanish regions. Many visitors selected Galicia as the destination for their holidays given the interest surrounding the *Prestige* oil spill and the need to experience the magnitude of the tragedy. This solidarity effect was encouraged by different advertising campaigns that promoted the image of Galicia as a desirable destination from January 2003 until the summer months. Also, some popular fish and shellfish species from Galicia, such as mussels, were also promoted in order to reduce the stigma

Table 9 – Domestic and foreign tourism

Domestic tourism expenditures (real prices 2001)(in € million)							
Destination	Tourism expenditures 2001	Tourism expenditures 2002	Tourism expenditures 2003	Tourism expenditures 2004	Difference expenditures 2002–2001	Difference expenditures 2003–2001	Difference expenditures 2004–2001
Domestic (Spanish tourism)							
Galicia	955.73	926.42	1012.76	988.69	−29.31	57.03	32.95
Asturias	447.75	428.13	458.98	660.23	−19.62	11.23	212.48
Cantabria	426.49	421.02	440.01	472.78	−5.48	13.52	46.29
Basque Country	273.42	311.64	374.62	429.17	38.22	101.20	155.75
Total Spain	20,013.08	19,869.25	22,897.37	25,933.03	−143.83	2884.29	5919.96

Source: Instituto de Estudios Turísticos (IET), Familitur Survey, several years.

Destination	Tourism expenditures 2001	Tourism expenditures 2002	Tourism expenditures 2003	Tourism expenditures 2004	Difference expenditures 2002–2001	Difference expenditures 2003–2002	Difference expenditures 2004–2002
Foreign tourism expenditures (real prices 2001)(in € million)							
Galicia	n.a	409.70	353.56	953.46	n.a	−56.14	543.76
Asturias	n.a	72.25	74.25	135.38	n.a	2.00	63.13
Cantabria	n.a	92.76	99.86	195.72	n.a	7.10	102.96
Basque Country	n.a	466.26	537.48	836.39	n.a	71.22	370.13
Total Spain	n.a	37,357.21	38,214.10	51,698.19	n.a	856.90	14,340.98

Source: Instituto de Estudios Turísticos (IET), Frontur Survey, several years.

Table 10 – Birds collected in different oil spills

Ship	Year	Place	Oiled birds collected	Mortality
Torrey Canyon	1967	Cornualles (UK)	7000	25,000
Amoco Cadiz	1978	Bretaña (France)	5000	22,000
Exxon Valdez	1989	Alaska (USA)	30,000	100,000–300,000
Braer	1993	Shetland (UK)	1500	5000
Sea Empress	1996	Gales (UK)	4600	10,000–15,000
Erika	1999	Bretaña (France)	77,000	150,000–300,000
Prestige	2002	Galicia (Spain)	23,181	115,000–230,000

Source: SEO BirdLife (2003).

effect caused by the oil spill. In order to promote tourism in Galicia and the rest of the Spanish coast impacted by the spill (the Cantabric Coast of Spain), the campaign "*España Verde*" (Green Spain) encouraged potential visitors to come to the affected area: Galicia, Asturias, Cantabria and the Basque Country. In the international arena, two other advertising campaigns were developed: "*Galicia Marks*," which promoted the image of Galicia in Portugal, France, United Kingdom and Germany, and a campaign made via banners (on-line campaign) that promoted the image of Galicia on the main tourism websites in Europe. The total cost of all campaigns was estimated to be around €19 million (Xunta de Galicia, 2004b).

In spite of the recent recovery of domestic visitors, the tourism surveys conducted among foreign visitors (Frontur) showed that revenues from foreign visitors in Galicia decreased considerably in 2003, with respect to 2002.[5] The Galician foreign tourism sector decreased revenues by €56.14 million in 2003, while this sector appears to perform well above the expected growth in 2004. The main reason for this excellent performance in 2004 was the fact that this year marked the Holy Year of Santiago de Compostela, the capital of Galicia. Motivated by cultural and religious motives, the Holy Year brought many tourists to Santiago de Compostela. Santiago is widely known as one of the most famous Christian pilgrimage destinations in the world after Rome and Jerusalem. Thus, in 2004 the number of foreign travelers and pilgrims widely increased due to the Holy Year Celebrations (*Xacobeo* celebrations).

7. Losses in utility from those visitors who came

Losses in utility from those tourists who came are probably important, although direct data are not available. Expenditures in souvenirs and general purchases (mainly gastronomic products and typical products) have decreased by about 15.73% (IGE). Unfortunately, estimates on WTP for enjoying a vacation of a certain quality are not available at this point. Bonnieux and Rainelli (2002) studied this aspect in the assessment of the damages caused by the *Erika* oil spill.

[5] Note that 2002 was the first year in which foreign visitors were surveyed, and hence, we do not account for data corresponding with 2001.

8. Environmental losses: birds and mammals

On August 31, 2003, a total of 23,181 birds were collected along the Spanish, Portuguese and French coasts, from which 6120 (26.40%) were still alive and 17,061 (73.59%) were dead (SEO Birdlife, 2003). In Galicia alone, there were 12,223 oiled birds collected. Three bird species were heavily affected by the oil spill: razorbill (*Alca torda*), common murre (*Uria aalge*), and Atlantic puffin (*Fratercula arctica*), which jointly account for 84.5% of the total birds soiled. Among all, the common murre was the most affected specie with 9359 oiled birds (47.9% of the total killed birds in Spain). (See Tables 10 and 11). However, previous estimations consider that the number of killed birds could be even much larger. In January 2003, the Spanish Society of Ornithology and Birdlife estimated that the number of birds killed by this oil spill was between 65,000–130,000, which would make the Prestige the second worst oil spill in history with respect to the number of killed birds. Other international studies conducted after the *Erika*, *Braer*, and *Exxon Valdez* oil spills present even a more negative outlook, showing that the percentage of collected birds is usually between 15–50% of the total affected. Consequently, we could expect that the number of killed birds may be as high as 115,000–230,000.

In order to assess the economic value of the killed birds and mammals we employed the reposition costs of each bird based on previous studies. However, as it is well known, one limitation of this method is that it relies on the market prices of the species being valued. Given that many of the affected birds impacted are classified as being in danger of extinction and commercialization is forbidden, there is no market price associated with these killed birds in Europe. In order to overcome this difficulty, we transfer the valuations employed in the *Exxon Valdez* oil spill (Brown, 1992), correcting them by the inflation rate and exchange rate. Multiplying the value of each of the corresponding species by the number of killed birds by specie, we conclude that the *Prestige* caused €6.372 million of damages (in 2001 prices) in the bird population (See Table 11). Due to the reasons expressed above, this is a lower-bound estimate, and in reality, total losses could be as much as 80% higher.

Marine mammals were also killed by the spill. A total of 33 dead mammals were collected in the beaches of Galicia until December 2002. From those, dolphins (12) and turtles (7) were among the most affected (See Table 12). As above, the valuation of whales and other endangered species is complicated by the fact that they do not have any associated market price, given that legal markets do not exist. Furthermore, the

Table 11 – Environmental losses from birds—*Prestige*

Common name	Scientific name	Total birds killed	Birds killed	Birds killed	Bird killed	Birds killed	Cost (€ 2001)
		Spain	Galicia	Asturias	Cantabria	Basque Country	Prestige
Common murre	*Uria aalge*	6492	3355	949	386	802	3,561,272.07
Atlantic puffin	*Fratercula arctica*	3272	2313	277	93	589	1,403,866.26
Razorbill	*Alca torda*	2617	2274	148	40	155	1,027,956.05
Yellow-legged gull	*Larus cachinnans*	607	531	28	11	37	133,991.93
Northern gannet	*Morus bassanus*	365	245	37	22	61	
Shag	*Phalacrocorax Aristotelis*	248	234	3	6	5	104,618.73
Black-legged kittiwake	*Rissa tridactyla*	71	46	0	2	23	21,052.74
Black-headed gull	*Larus ridibundus*	54	42	5	0	7	15,789.56
Great cormorant	*Phalacrocorax Carbo*	62	37	14	3	8	28,088.30
Dovekei	*Alle alle*	51	37	7	0	7	21,947.96
Common scoter	*Melanitta nigra*	31	31	0	0	0	21,667.01
Lesser black-backed	*GullLarus fuscus*	34	31	2	0	1	8114.08
Great skua	*Catharacta skua*	26	11	1	0	14	
Common loon	*Gavia immer*	25	20	5	0	0	11,424.42
Northern fulmar	*Fulmarus glaciaris*		18	8	4	0	6
European storm-petrel	*Hydrobates pelagicus*	12	10	0	0	2	5909.18
Herring gull	*Larus argentatus*	7	7	0	0	0	2631.59
Great Black-backed gull	*Larus marinus*	8	8	0	0	0	1754.40
Pardela balear	*Puffinus mauretanicus*	2	2	0	0	0	1617.82
Mediterranean gull	*Larus melanocephaalus*	2	0	0	0	2	657.90
Others		620	515	43	9	53	.
Total valued		14,004	9242	1480	563	2719	6,372,360.00

Source: SEO BirdLife (2003) and Brown (1992).

lack of previous valuation studies of other species (such as dolphins) does not allow us to transfer any assigned economic value. Consequently, we only value the minke-whale by transferring previous estimations undertaken by Loomis and Larson (1994). Although we acknowledge that this benefit transfer is not exact due to the differences in both whale species, this remains the best possible approximation that could be calculated at this point. The killing of one minke-whale was estimated to represent €18,745,828 in total losses for Galicia. As far as we know, no direct reductions on use values derived from watching and enjoying these species have been yet estimated.

9. Cleaning-up and recovery costs

A large amount of public funds were allocated to the cleaning, recovery, and storage of the oil spilled. The total budget dedicated to these tasks in Galicia alone was about €199.6 million; while in the total affected area added to €234.8. This budget was mainly used for general expenditures such as personnel, goods and services required to complete the cleaning operations in beaches and affected coastal areas, and technical equipment related to pollution control. Investment in pollution control amounted to €22.61. Realistically, we can assume that after the oil recovery operation, these capital goods and technical equipment still possess some residual value. This value depends on each particular good, although on average terms we can assess current worth being 30% of their initial value as the remaining commercial value. Note that Grigaluanas et al. (1986) estimated the residual value of capital investment being 25% of the initial investment made in the *Amoco Cadiz*. Thus, in our final estimate, we subtract the residual value (about €6.78) from the total cleaning costs.

In addition to direct cleaning costs, about €100 million more were needed to extract the oil from inside the tanker at

Table 12 – Number of affected mammals and turtles

Name	Scientific name	Dead	Total value lost Galicia	Total Spain	Value	Lost
Kemp's ridley, Atlantic ridley	*Caretta caretta*	7				
Bottlenosed dolphin	*Tursiops truncates*	5				
Harbour porpoise	*Phocoena phocoena*	3				
Risso's dolphin	*Grampus griseus*	1				
Short-finned Pilot whale (or Shortfin pilot whale)	*Globicephala melas*	2				
Common dolphin	*Delphinus delphis*	6				
Minke whale	*Balaenoptera acutorostrata*	1				
Others		8	18,745,823.3			

Source: Alonso Farré and López Fernández, 2002.

the bottom of the sea. Furthermore, an additional budget of €32 million was employed to cover expenditures related to reclining residues collected from the tanker. Aside from these direct costs incurred by the Spanish and the local Autonomous governments [6] (regional governments), the local municipalities incurred also in cleaning costs. The local municipalities obtained a compensation of €123.5 million to cover additional cleaning costs and any other indirect costs resulting from the oil spill (and being mainly related to the lack of commercial activity). In sum, and after subtracting the residual capital of the initial cleaning investment, total cleaning costs amount to €483.52 million. In spite of its large magnitude, this previous sum remains an incomplete figure and does not reflect most of the associated labor costs linked to the cleaning operations.

Most of the labor costs were provided for free by the volunteers, who were not paid or compensated for their time. Note however, that other expenditures caused by the presence of such volunteers, including food and lodging are already included in the expenses previously presented and incurred by the public administration. Registered volunteers worked a total of 325,345 days from November 2002 to July 2003 only in Galicia to clean the affected beaches and coastal areas (Xunta de Galicia (2004c)). In total, about 72.43% of these working days were used to clean the Northwest coast (around Finisterre Cape), which was the most affected (in particular, the municipalities of Carnota, Muxía, Camariñas and Fisterra).

In order to obtain a crude approximation of the labor cost saved by their contributions, we multiplied the daily minimum wages in real prices in Spain in 2002 (€14.75) and 2003 (€15.04), respectively, by the number of working days in each year, obtaining an estimate of €4.858 million. Thus, overall the amount of the total labor costs is quite significant, although we acknowledge that we can only approximate its value with this raw estimate. The main difficulty we found in computing labor costs is that data on occupation per volunteer are not available. Note that the above estimate assumes that students may receive the daily minimum wage, although it is quite uncommon that Spanish students participate in the labor market. Although data on volunteers' occupations are not available, we can subtract the total working days from those individuals coming from Universities, assuming that these individuals are mainly students. We conclude that total labor costs amount to €4.034. This estimate is rather conservative, given that it ignores transportation time with its associated costs, and assumes that all working volunteers receive the minimum wage.

10. Other costs

In addition to the previously outlined costs, there are other costs (such as the costs of legal representation, and health related problems of volunteers and cleaning teams) that should also be considered.

Unfortunately, data are not available regarding the legal costs of presenting damage claims and liability charges. With respect to health effects suffered by cleaning personnel and volunteers, evidence about the health effects is clear, although associated economic costs are not computable with the current data. A study conducted by Gestal-Otero et al. (2004) showed that four months after the accident, volunteers working in March 2003 in the Galician coast possessed a comparable concentration of organic volatile substances in their blood as those individuals living in cities with high traffic density. Additionally, volunteers who worked in April 2003 showed similar concentration levels of volatile substance as those of individuals living in highly polluted cities. It is also acknowledged that more acute health problems would have been found if surveying had been conducted directly after the spill. Unfortunately, we are not aware of any study that assesses the long-term health effects suffered by volunteers and cleaning personnel. Thus, we are unable to measure the economic losses due to these health impacts (measured by the number of working days lost due to health problems, higher volume of expenditures in medicines, or by the reduction of life expectancy, etc.).

11. Total costs

In spite of the fact that this cost assessment uses secondary data, we conclude that the economic magnitude of the catastrophe caused by the *Prestige* oil spill is rather significant. Short-term losses in all affected economic sectors in Galicia plus all environmental losses accountable at this point, as well as cleaning and recovery costs, add to a total of €566.97 million during the period 2002–2004, while excluding all other financial and future losses. These losses are rather important for a small economy such as the Galician one, which posted a gross domestic product (GDP) in 2002 of €36,097 million. Thus, in percentage terms, the total costs associated with the oil spill represent about 1.57% of the total Galician GDP. Total losses in the affected area (including the regions of Galicia, Asturias, Cantabria and Basque Country) for the years 2002–2004 amount to €770.58 million (See Table 13).

In order to reduce the impact of the accident on the local economy, transfers were made to affected individuals and private parties by the several regional and central Spanish governments, as well as by the EU supranational government and the IOPC Fund. Although some interested parties consider that these transfers have offered fair compensation for incurred damages, our estimates show otherwise. Note that these transfers are not computed as direct or indirect commercial costs linked to the spill.

Regarding compensation requests to the IOPC Fund, in June 20, 2005, the IOPC office received claims for €743.73 million. This amount is smaller than the magnitude of our total cost estimate for the total affected area, and it could be also understood as a lower-bound estimate of the total net costs. As in previous oil spills, such as in the *Braer*, only about 30% of the affected individuals presented compensation claims. Data are not available yet on the amounts claimed versus the

[6] Spain is divided into 17 Autonomous regions (Comunidades Autónomas) with their own rights and obligations, although overall these Autonomous regions are dependent on the Spanish central government. This system is somewhat similar to other federal systems implemented in the United States or Germany.

amounts approved for compensation. However, it is expected that due to the small compensation limit of the applicable IOPC fund (€165.76 million or $199 million), only a small part of the total costs would be recovered. Furthermore, previous experiences with compensation claims in oil spills demonstrated that only a small proportion of the total damages are recovered. For example, in the *Erika* oil spill, estimated damages amounted to €526.2–611 million, while the total compensation claims presented in court were only €83.2 million, from which only €15.1 million were paid by the IOPC Fund. In the case of the second most recent spill in Europe, the *Sea Empress*, the total damage was estimated about €68.1–129.3 million, while the amount claimed in court was €56 million and the amount paid after more than five years waiting was €57.8 million (See Thébaud et al., 2004).

As reported in Table 13, currently, the *Prestige* oil spill's cleaning costs and other palliative measurements constitute the highest share of the estimated costs, representing about 66.10% of the total. Thus, future studies about efficiency of different cleaning techniques should be undertaken in this region. However, environmental damages when evaluated may become a very large component of the total costs linked to the spill.

Table 13 – Total Costs (in million €)

Total costs	Estimate Galicia	Estimate All affected area	Claims Galicia	Claims Total Spain
(1)Commercial and Environmental Losses				
Commercial losses in fisheries (2002–2004)	63.08	112.66	133.75	134.31
Commercial losses in the mussel sector	12.83	12.83	7.94	8.03
Commercial losses in the canning and fish processing sector (2002–2004)	22.50	26.77	9.94	13.53
Losses in the domestic and foreign tourism sector (2002 and 2003)	85.45	110.55	0.49	0.61
Losses in recreation	n.a.	n.a		
Birds and mammals	22.29	25.12		
Total (1)	184.05	261.16	152.12	156.48
(2)Cleaning-up, recovery and other palliative measurements				
Cleaning and recovery costs minus residual values of investments	192.82	228.02		
Extraction of fuel inside tanker	100.0	100.0		
Recycling of residuals	24.0	32.0		
Expenditures by local communities and the autonomous governments	40.2	123.5		
Volunteers	4.0	4.0		
Losses in other goods	2.6	2.6	2.64	3.85
Advertising and promotion	19	19		
IGAPE support to the mussel sector	0.3	0.3		
Total (2)	382.92	509.42	n.a.	583.40 (c)
*(3)Other expenditures—only partially recoverable**				
Transfers to fishermen and shellfish pickers while fishing and shellfish bans were in place (a)	114.2	134.3		
Other compensations to private parties (b)	73.3	94.0		
Total cost claimed			n.a	743.73
Total estimated cost, excluding the IOPC first aid and FIFG funds	566.97	770.58		
Maximum compensation allowed under the IOPC 1992 fund	165.76 (d)			

12. Conclusions and limitations of the current study

In this paper, we attempt to assess the total commercial, cleaning and recovery costs caused by the *Prestige* oil spill. As pointed out earlier, the Northern coast of Spain, in particular Galicia, has suffered through multiple oil spills, although no complete cost assessment exists for any previous accident. This is one of the first attempts made to measure the total losses caused by an oil spill in Galicia (NW Spain), which is one of the areas of the world with the highest frequency of spills.

We acknowledge that in spite of the magnitude of the total costs, the cost estimates are only lower bound estimates. Several reasons contribute to this fact. First, commercial losses related to fishing and shellfish extraction sectors are not easy to compute with the available statistics. Although reductions in landings of inshore fishing and shellfish are quite significant in the months after the *Prestige* oil spill, the official data available do not properly differentiate between domestic and imported fish. The lack of solid statistical data limits the analysis of the economic losses in the productive sectors. This deficiency should be corrected to properly

Notes to Table 13:
Note: Cleaning and recovery costs were obtained from various public sources. Among them: Ministerio de Presidencia (14/05/2003), Xunta de Galicia (10/11/2003), Diario Oficial de Galicia (DOGA: Wednesday 22 of January, 2003).
(a) Part of these funds (about €100 million for the total affected area) came from the E.U. Financial Instrument for Fisheries Guidance (FIFG) and the rest was provided (€ 34.3) by the Spanish Government.
(b) The first €57.5 million out of the total came from The International Oil Pollution Compensation Funds (IOPC Funds) as first emergency funds.
(c) Cleaning costs claimed by the Spanish government also include the proportional part of transfers provided in the first reaction to the accident, corresponding with concepts presented in (a) and (b) above.
(d) The exchange rate applied was €1=$1.2006, so that $199 million equal €165.76.

account for the total losses, and also to claim future damages and accurate levels of compensation. Second, the environmental losses presented in this study do not reflect all natural resources damaged. At this point there is a great need to continue with research in the field, assessing the losses of use and non-use values caused by the *Prestige* oil spill. In this sense, the lack of field work does not allow us to assess the loss in satisfaction of visitors or residents who enjoy and frequently visit the beaches and parks affected by the spill. We are also not able to assess the substitution effects among beaches and recreational activities. Furthermore, the total magnitude of the non-use values lost in the spill still remains unknown. These non-use values could be very large, given the strong public reaction of the Spanish and Galician people. Contingent valuation studies would allow us to approximate these non-use values, as well as to reproduce estimates for natural species which do not count with a transaction value. However, in spite of all the shortcomings mentioned, the computed cost or short-term economic damage caused by the *Prestige* oil spill is rather important to the Spanish society and especially to the region of Galicia.

We expect that this preliminary effort will be further complemented with other future analyses of the long term consequences of this environmental disaster, as it has been done, for example, in the case of the *Exxon Valdez* oil spill (See Fall et al., 2001). This would enable researchers to respond to all remaining questions that currently cannot be answered in a satisfactory manner.

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