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What Have We Learned from the Deepwater Horizon Disaster? An Economist's Perspective

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What Have We Learned from the Deepwater Horizon Disaster? An Economist's Perspective

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1. INTRODUCTION

The *Deepwater Horizon* (*DWH*), an oil rig working for BP on the Macondo exploration well in the Gulf of Mexico, experienced a gas leak while closing out the well and subsequently exploded on the evening of April 20, 2010, killing eleven men and injuring many others. It subsequently burned and sank to the sea floor, and as a result of the blowout, between 3.26 and 5 million barrels of oil were released into the waters of the Gulf, becoming the largest accidental marine oil spill in history.

What followed was a massive response on multiple fronts to contain the well (which finally succeeded on July 15, 2010). Efforts were made to capture, disperse, or burn the spilled oil; to protect coastal shorelines with boom and other devices; and to rescue and treat injured marine and other wildlife. Additionally, scientists and other personnel were sent out to establish pre-spill baselines, and policymakers responded with the issuance of new safety rules and a temporary moratorium on deepwater drilling (that lasted until October 12, 2010).

What also followed was a fairly large research effort to figure out what went wrong and why. This included work to measure the effects of the spill as well as forward-looking research to better prepare for and mitigate the effects of future spills. Funds for these efforts came from many sources, but the largest of these was BP—who committed to providing $500 million over the course of ten years through the Gulf of Mexico Research Initiative (GOMRI)—and the National Science Foundation (NSF)—which funded over $19 million in rapid-response grants and just under $10 million in subsequent funding for research directly related to the *DWH* spill.

This paper aims to outline what we have learned about the impacts of the *DWH* disaster from the economics discipline as well as what effect the *DWH* disaster has had on the discipline itself. It appears that what we currently know about the economic impact of the *DWH* oil spill is limited, possibly because such analysis is tied up in the federal Natural Resource Damage Assessment (NRDA) process and/or other state-led efforts. There is evidence, however, that the NRDA process has changed over time to de-emphasize economic valuation of damages (see Barbier 2011a), meaning that there may not be much NRDA-based economic research to speak of. Moreover, there is evidence that economists may be producing fewer outputs as a result of the *DWH* relative to scholars from other disciplines

because of an apparent absence of research *inputs*, i.e. public funding (that is, non-litigation based, independent research funded by either private or public sources and carried out by either private or public sources purely for the sake of research), for economics research related to the *DWH*. Of the research that has taken place since the *DWH* disaster, this paper provides a summary and highlights the main directions of future research spurred by the *DWH*. It appears that the most pressing topic covered thus far in the economics (and related) literature focuses on addressing the incentives and policies in place to promote a culture of safety in the offshore oil industry, especially for deepwater drilling. Also, it appears that the most prominent, and challenging, direction of future research resulting from the *DWH* is the expansion of an ecosystems services approach to damage assessment and marine policy. First, the paper looks back at the Exxon *Valdez* disaster of 1989 and how it impacted the economics discipline.

2. LOOKING BACK: THE EXXON *VALDEZ*

Prior to the *DWH* disaster in 2010, the Exxon *Valdez* accident in Prince William Sound, Alaska, served as the "high-water mark" for marine oil spills in the U.S. It, along with other oil accidents, led to the passage of the Oil Pollution Act of 1990 (OPA), which changed the rules of the game for the NRDA oil spills process (see Barbier 2011a for a detailed discussion of the OPA and the NRDA process). The OPA makes parties releasing oil into the environment liable not only for the cost of cleaning up those releases, but also for monetary compensation for damages, and authorizes public trustees to seek recovery of these damages (Barbier 2011a). It substantially increased spillers' explicit liability for damages, making them liable for loss of natural resources, personal property, subsistence use, taxes, royalties, rents, fees, net profit shares by government entities, profits and earning capacity, and changes in costs of public services provision. The OPA also established the Oil Spill Liability Trust Fund, which may be used to pay for cleanup and damages not paid for by the spiller, and provides that costs of initiating the NRDA may come from the fund.

Specific to the field of economics, the *Valdez* oil spill was a major catalyst (if not *the* catalyst) for the exponential growth in non-market valuation research, specifically stated-preference methods, and especially the contingent valuation method (CVM), which was at the center of a controversy about whether passive-

use values were measurable and admissible in court as a legitimate type of damage (Carson et al. 2003). Specifically, Exxon sponsored a conference featuring research that concluded that the CVM was unreliable (Hausman 1993). In response, the National Oceanic and Atmospheric Administration (NOAA) commissioned a "Blue Ribbon" panel, co-chaired by Nobel Prize winners Kenneth Arrow and Robert Solow, to assess the validity of CVM. The panel concluded that, under the right conditions, the CVM could provide lost passive-use value estimates that could serve as a legitimate starting point for litigation (Arrow et al. 1993). Subsequently, two symposia were put on to address the issue, one by the American Agricultural Economics Association in 1993 (Carson, Meade, and Smith 1993; Desvousges et al. 1993; and Randall 1993), and another by the American Economic Association (AEA) in 1994 (Portney 1994: Hanemann 1994, and Diamond and Hausman 1994). From this point, stated-preferences research proliferated, building upon the work conducted prior to *Valdez,* such as Randall et al. (1974) and Mitchell and Carson (1989), and eventually led to the growth of the use of choice experiments for non-market valuation. Since then, Carson (2011) has documented over 7,500 scholarly articles on CV, although Carson and Hanemann (2005) point out that most of the work that followed had more to do with increased demand for comprehensive benefit-cost assessments than with *Valdez*.

The *DWH* disaster reignited the sparks of *Valdez,* and the most visible and high-level response in the economics field was a second contingent valuation symposium sponsored by the AEA in 2012 (Kling, Phaneuf, and Zhao 2012; Hausman 2012; Carson 2012). Kling, Phaneuf, and Zhao (2012) provide a balanced view of the CVM, focusing on four validity criteria (criterion, convergent, construct, and content). Carson (2012) summarizes the progress made on the CVM since *Valdez,* pointing out that many of the issues raised by critics can be directed not only to contingent valuation data but to market data, as well. He concludes that contingent valuation remains a practical valuation alternative. Hausman (2012) selectively reviews the literature since *Valdez,* fails to find progress since then, and declares the method "hopeless." Although the previous two papers offer some counterarguments to the assertions made by Hausman (2012), they do not provide specific responses to his arguments. Haab et al. (2013) fill this gap by responding directly to Hausman's points regarding hypothetical bias, the divergence between willingness to pay and willingness to accept, and the lack of scope effects.

Beyond the second symposium sponsored by the AEA and the response by Haab et al. (2013), however, the question is whether the *DWH* has and/or will invigorate and extend economic valuation research like the *Valdez* spill did. Although the papers in the 2012 AEA symposium use this prospect to motivate their discussions, evidence to the contrary does exist. Unlike the *Valdez* case, which was followed by a very public debate regarding the contingent valuation method that stimulated years of valuation research, no evidence suggests a similar impetus following the *DWH*. Barbier (2011a) points out that, prior to the passage of the OPA, economic valuation of damages was essential to the NRDA process—thus explaining the heavy emphasis on contingent valuation methods post-*Valdez*. Following passage of the act, however, the NRDA process was changed to de-emphasize the role of, and need for, economic valuation of damages altogether. In this way, the legal wrangles over damage compensation as experienced post-*Valdez* could be largely avoided. Therefore, if Barbier is right, we may not see many economic research outputs come out of the NRDA process. Nonetheless, it is possible that this will shift demand for economic valuation research to those states pursuing legal compensation separate from, and in addition to, the NRDA process. We can get some sense of what to expect from efforts *outside* of the NRDA process by examining both the kinds and magnitude of research funding provided as a result of the *DWH* as well as what can be found in the relative economics literature.

3. POST-*DWH* RESEARCH FUNDING

A review of research projects funded by the National Science Foundation since April 2010 reveals that 168 *DWH*-focused projects were funded through NSF's Rapid Response Research program, with aggregate funding of just over $19 million. To identify such projects, the keyword search terms of "deepwater horizon", "bp oil", "gulf of Mexico oil" and "macondo blowout" were used (see Table 1 on next page).

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Table 1. National Science Foundation Grants focused on *DWH* Oil Spill, by NSF Directorate

	RAPID				Non-RAPID			
NSF Directorate	**# Projects**	**%**	**Funding**	**%**	**# Projects**	**%**	**Funding**	%
BIO	36	21.4	$4,811,191	25.1	6	10.3	$698,013	7.0
CSE	11	6.5	$1,371,014	7.2	3	5.2	$898,492	9.0
EHR	1	0.6	$200,000	1.0	4	6.9	$798,438	8.0
ENG	31	18.5	$3,589,959	18.8	7	12.1	$916,654	9.2
GEO	74	44.0	$7,994,257	41.8	26	44.	$3,916,663	39.4
MPS	9	5.4	$910,751	4.8	9	15.5	$2,150,751	21.6
SBE	6	3.6	$261,386	1.4	3	5.2	$570,322	5.7
Total	168		$19,138,558		58		$9,949,333	
SBE Projects Including Economic Analysis	*0*		*$0*		*0*		*$0*	

Of these, only 6 of the funded projects were categorized under the Directorate for Social, Behavioral, and Economic Sciences (SBE), with total funding of $261,386. This number of projects represents 3.6% of the total number of projects funded and 1.4% of total funding. Only the Directorate for Education and Human Resources had fewer projects funded and lower funding. Of the 6 SBE projects funded, two were under the Division of Behavioral and Cognitive Sciences, and sub-categorized under the cultural anthropology program. The remaining 4 came under the Division of Social and Economic Sciences; of these, 2 were sub-categorized under the political science program, and the other two under the decision, risk, and management science program. These latter two would seem to be the two most likely to address economic aspects of the oil spill. It turns out, however, that both are actually focused on nuclear energy: one focuses on how the *DWH* disaster affects Americans' perceptions of and preferences for nuclear energy, and the other focuses specifically on the Fukushima nuclear disaster. Thus, it appears that none of NSF's Rapid Response Research funding went to any research focused on economic impacts or other economic issues related to the *DWH* disaster. Although NSF is obviously distinct from the NRDA process, it is possible that, perhaps, NSF's funding decisions were influenced by the shift in emphasis in the NRDA process away from economic valuation of damages, rendering such work a low priority, even for NSF.

In addition to Rapid Response Research funding, another 58 NSF projects were identified as related to the *DWH*, with aggregate funding of just under $10 million (see Table 1). Of these 58, three were under the SBE Directorate, which, along with

the Directorate for Computer & Information Science & Engineering, had the fewest projects. In terms of funding, SBE had the least. Of these 3 SBE projects, one came under the Division of Behavioral & Cognitive Sciences, and focused on community adaptation to changing disasters, and the other two came under the Division of Social & Economic Sciences. Of these latter two, one examines the effect of the media on public perceptions of an event, and the other focuses on something called Ushahidi, which is a method developed for "crowdsourcing" the monitoring of disasters. While these projects may address important issues pertinent to the *DWH*, it appears unlikely that any of these address issues specific to economic impacts, theory, or methods.

Turning to other federal agencies, a search of grant opportunities on the Grants.gov website, which encompasses most federal sources of publically-available research funds, the same keyword searches as used above for funding opportunities since April 2010 resulted in 13 hits, with total estimated funds of just under $23 million (see Table 2). Closer inspection of these opportunities indicated that none of these, with the possible exception of the one Economic Development Agency opportunity, includes economic analysis of any kind[1].

Table 2. Grant Calls for Proposals Listed on Grants.gov by agency (USD)

	Agency						
	BSEE	**EDA**	**EPA**	**FWS**	**NIH**	**NMFS**	**NPS**
# RFPs	1	1	2	1	1	5	2
Est. Funds	5,000,000	?	300,000	31,700	5,300,000	12,000,000	265,107
Econ. Analysis?	No	Maybe	No	No	No	No*	No

*Only one of the 31 individual MARFIN-funded projects explicitly addresses the *DWH* spill, and it does not include economic analysis.

A search of the funded awards database for the four Gulf of Mexico Sea Grant programs (Florida, Louisiana, Mississippi-Alabama, and Texas) resulted in 30 projects directly related to the *DWH* oil spill since 2010, with total funding of $3,693,718 (including Sea Grant, match, and pass-through funds) (NOAA 2014).

[1] EDA annual reports include a list of projects funded under all supplemental disaster assistance programs. Of those listed for the five Gulf states, most appear to be granted to city or county governments for various construction projects, and those granted to colleges and universities appear to be directed to various entrepreneurial centers, workforce training programs, etc. So it appears that these funds did not go toward economic research, *per se*, but to economic development activities.

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Of these 30 projects, only one appears to include any economic analysis, although the database shows no actual funding assigned to this project.

Other potential sources of research and/or funding are the individual Gulf states. As mentioned earlier, the de-emphasis on economic valuation of damages at the federal level may have the effect of increasing demand for it at the state level. It appears that at least one of the Gulf states is involved in additional litigation efforts separate from the NRDA process, and has funded some economics work as part of that litigation (Larkin, Huffaker and Clouser acknowledge funding from the Office of Economic and Demographic Research of the Florida Legislature to estimate economic impacts of the *DWH* spill in their 2013 study). It is likely that other Gulf states are doing the same. Based on searches of state websites and publication archives, as well as personal communications with individuals in these states, however, only one instance of state funds being directed explicitly for the *DWH* spill was found. Neither has the Gulf States Marine Fisheries Commission sponsored or conducted any such work.

The lion's share of research funding related to the *DWH*, however, is through the Gulf of Mexico Research Initiative (GOMRI, see Table 3), which describes itself as "BP's commitment to provide $500 million in funding over the course of 10 years for independent scientific research related to the *Deepwater Horizon* incident," (GOMRI 2014).

Table 3. GOMRI Grant Funding by Phase

	All Projects		Projects with Economic Analysis			
Funding Phase	**# Projects**	**Funding**	**# Projects**	**% of Total**	**Funding**	**% of Total**
Year 1 Block Grants	158	$45,000,000	1	0.6%	$149,999	0.3%
RFP I	8	$110,000,000	0	0.0%	$0	0.0%
RFP II	19	$18,500,000	0	0.0%	$0	0.0%
RFP III	17	$1,500,000	0	0.0%	$0	0.0%
Total	202	$175,000,000	1	0.5%	$149,999	0.1%
Total Personnel	2,269		2	0.1%		

GOMRI's first action was to provide $45 million in the form of block grants to four Gulf state institutions (Florida Institute of Oceanography, Louisiana State University, Marine Environmental Science Consortium, and Northern Gulf Institute) and the National Institutes of Health in 2010-2011. Of the 158 individual research projects undertaken under the auspices of these five entities, only one

focused on some aspect of the economic impacts of the *DWH* spill, awarded to a single researcher in a finance department. No others appear to focus on economic research of some kind. GOMRI has since released 4 Requests for Proposals (RFPs), and has funded 3 of them (RFPs I, II, and III). RFP IV closed in mid-2014with award announcements expected in late 2014. Of the 8 consortia (RFP I) and 36 projects (RFPs II and III) already funded, none appear to address any economic research questions, and this is supported by the fact that, of the 2,269 individuals listed on the GOMRI website as personnel involved in one or more GOMRI projects, none appear to be housed in an economics, applied/environmental/agricultural economics, finance, or business program or similar outfit, except for the lone faculty member and master's student carrying out the one project mentioned earlier (based on a keyword search for "economics" of all funded project titles and abstracts, as well as one for "economics", "finance" or "business" in the contact information for all GOMRI-funded personnel listed on the GOMRI website). Thus, of the $175 million in funds released thus far by GOMRI, about one-half of 1% has been directed to economic research of some kind. RFP IV does appear to open the door to economics research related to the spill, but does so only as a potential sub-focus under the theme of public health. Theme 5 under RFP IV addresses the "Impact of oil spills on public health including behavioral, socioeconomic, environmental risk assessment, community capacity, and other population health considerations and issues." The "Q & A" section of the GOMRI website for RFP IV directs those seeking more information on Theme 5 (the one that mentions economics) to a summary of a GOMRI workshop held in July 2013. In that summary, it states:

> "At the community level, research topics could focus on community resilience, cultural/socioeconomic differences, ecosystem services, modeling, translating and processing scientific information, risk communication, decision science, community-based participatory research, ethnographic methods, economic impacts, and community-wide mental health effects.
>
> At the individual level, research topics could focus on psychological and physical health, risk management, intervention science, seafood and occupational safety, and composite exposures." (GOMRI 2013)

Whether any economic research will come out of RFP IV remains to be seen.

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I turn now to funds directed to the NRDA process itself. A search of the USASpending.gov site (Office of Management and Budget 2014), which features a ready-made "Gulf Oil Spill" search prominently on the main page (as of July 7, 2014), it appears that, based simply on project descriptions (e.g., "lost direct and passive human use values") and firm names (e.g., containing the word "economics"), that approximately $319 million have been directed to two private consulting firms to conduct some kind of economic analysis (the sum of "dollars obligated" for Industrial Economics, Inc. and Straus Consulting, Inc., comprising 54% of overall spending for the Gulf Oil Spill). However, it is likely that the results of this research will not become public record, or if it does, it will be quite some time until it does. Thus, the economic research funded in this way may or may not become part of the literature accessible to the public and other researchers. Then again, if Barbier (2011a) is right, then whatever research these funds are supporting may turn out to be something altogether different.

4. ECONOMICS LITERATURE PERTAINING TO THE *DWH*: HOW MUCH IS OUT THERE?

Turning to the "output" side, we find mixed evidence for the quantity of research publications related to, or resulting from, the *DWH* spill. A keyword search of "*Deepwater Horizon*" in Google Scholar results in 13,300 hits, excluding citations and patents (see Table 4). The same search with the term "economic", "economics", "economic analysis", or "economic impact" added to it limits the search to 73%, 41%, 8%, and 6%, respectively, of the original total. Google Scholar also allows for an "In title only" search. Under this more restricted search, the "*Deepwater Horizon*" search yields 788 hits. Adding the various economic terms enumerated above yields 1.4%, 0.1%, 0.1%, and 0.3% of the original total, respectively. It is worth noting that the analogous keyword searches for "Exxon *Valdez*" yields similar results. So this relative shortage does not appear to be unique to the *DWH* spill.

Scopus is an academic index that claims to be "the largest abstract and citation database of peer-reviewed literature" (Elsevier 2014). A keyword search in Scopus for "*Deepwater Horizon*" results in 1,187 hits. If limited to Scopus's "Social Sciences & Humanities" subject areas, the result is 265 hits. Of these, only 16 are in the subcategory "Economics, Econometrics, and Finance". To give some

perspective, a keyword search of the term "Exxon *Valdez*" yields 878 hits. Only 110 of these are in "Social Sciences & Humanities" subject areas, and of these, 24 qualify as articles in the subcategory "Economics, Econometrics, and Finance".

Table 4. Results of Google Scholar Search

	Exxon *Valdez*		*Deepwater Horizon*	
Search Terms	**Hits**	**% of Total**	**Hits**	**% of Total**
	General Search			
"Exxon *Valdez*" / "*Deepwater Horizon*"	25,100		13,300	
"+ economic"	18,200	73%	7,320	55%
"+ economics"	10,300	41%	3,860	29%
"+ economic analysis"	2,120	8%	604	5%
"+ economic impact"	1,610	6%	808	6%
	In Title only			
"Exxon *Valdez*" / "*Deepwater Horizon*"	827		788	
"+ economic"	7	0.8%	11	1.4%
"+ economics"	1	0.1%	1	0.1%
"+ economic analysis"	2	0.2%	1	0.1%
"+ economic impact"	1	0.1%	2	0.3%

Similarly, a keyword search for "*Deepwater Horizon*" in the American Economic Association's electronic bibliography database EconLit (AEA 2014), which indexes over 120 years of economics literature from around the world, results in 23 hits since 2010, 13 of which are journal articles (see Table 5). If the search is expanded to include the terms "oil spill" or "Gulf of Mexico oil" as well, then there are 75 hits, 49 of which are journal articles. However, not all of these address the *DWH* spill directly, and some are not actually related at all. By comparison, the keyword search "Exxon *Valdez*" yields 32 hits since 1989, 24 of which are academic journal articles.

Table 5. Keyword Search Results for EconLit and IDEAS/RePEc since 2010 (1989 for *Valdez)*

	EconLit		IDEAS / RePEc	
Search Terms	**Total**	**Academic Journal Articles**	**Total**	**Academic Journal Articles**
"*Deepwater Horizon*"	23	13	37	19
"*Deepwater Horizon*", "oil spill", or "Gulf of Mexico oil"	75	49	393	55
"Exxon *Valdez*"	32	24	40	31

A keyword search for "*Deepwater Horizon*" in the IDEAS database of RePEc (Research Papers in Economics 2014) yields somewhat more hits, in this case 37 since 2010, 19 of which are academic journal articles (see Table 5). Expanding the search to include the terms "oil spill" or "Gulf of Mexico oil" as well increases the hits to 393, 55 of which are journal articles. By comparison, "Exxon *Valdez*" yields 40 hits since 1989, 31 of which are academic journal articles. So, there appears to be mixed evidence as to the quantity of economics-related output. Relative to other disciplines, the amount appears very small. However, limiting the search to economics-focused databases, the quantity of output ranges from a low of 23 publications to a high of 393[2]. Furthermore, we should point out that many of the economic hits cited here are papers that report *potential* economic impacts or preliminary assessments of the *DWH*. We now turn to a summary of the research issues emerging and contributions already made by the literature found in the aforementioned searches.

4.1 Economics Literature pertaining to the *DWH*: Specific Contributions

The bulk of extant literature related to the *DWH* incident focuses on the incentives and policies in place to promote a culture of safety in the offshore oil industry, especially for deepwater drilling. Other areas addressed include impacts on wetland

[2]These would include papers such as Aldy (2011); Hanson and Baker (2011); IEM (2010); Mendelssohn et al. (2012); Oxford Economics (2010); Posadas and Posadas (2013); Sumaila et al. (2012); and Upton (2011).

restoration efforts, fisheries, real estate, consumer choice and perceptions of seafood, and public attitudes on oil production and spills.

4.1.1 Safety in the Offshore Oil Industry

Anderson et al. (2011) address industry safety with particular focus on the Marine Well Containment Company (MWCC), a consortium aimed at designing and building a system capable of containing future deepwater spills in the Gulf. They focus on the roles of liability and regulation as determinants of readiness and the adequacy of incentives for technological innovation in oil spill containment technology to keep pace with advances in deepwater drilling capability.

Cohen et al. (2011) discuss the economic and policy forces that affect oil drilling safety and identify reasons why those forces may or may not be effective. Concerned that raising liability caps without mandating insurance or increasing financial responsibility requirements could have little effect on small firms that would sooner declare bankruptcy, they recommend a liability cap for each well equal to the worst-case social costs of a spill and require insurance up to the cap.

Cooke, Ross, and Stern (2011) apply the Accident Sequence Precursor (ASP) program, originally developed in response to the Three Mile Island nuclear meltdown, to the challenges of low-frequency high-consequence events such as the *DWH* spill. The ASP approach foregoes in-depth modeling at individual facilities and uses instead generic event trees to reflect macroscopic design of safety systems. The approach lacks detail but captures system dependencies missing in Probabilistic Risk Analysis (PRA). They recommend this approach a promising means of promoting cost-effective, risk-informed oversight on the industry.

Viscusi and Zeckhauser (2011) propose a regulatory and liability framework to encourage parties involved in offshore drilling to take appropriate actions. This proposal replaces the current structure of a low damages cap coupled with ineffective regulation with a system that greatly expands the level of liability, coupled with a tax, to provide incentives for risks beyond the liability limit. They argue that this system creates strong financial incentives for safety.

Muehlenbachs, Staubli, and Cohen (2013) analyze the effect of the number of inspectors as well as the effect of familiarity between inspector and inspected party on the severity of sanctions issued. From these results, they estimate the effectiveness of increasing enforcement on the deterrence of incidents, but find only

weak evidence that increasing sanction severity increases deterrence. Muehlenbachs, Cohen, and Gerarden (2014) analyze company-reported incidents on offshore oil platforms between 1996 and 2010 and find that, controlling for other factors, each 100 feet of added depth increases the probability of an incident by 8.5%, suggesting the need for increased monitoring of deeper-water platforms.

4.1.2 Wetland Restoration

Barbier (2011a) summarizes the current status of wetland restoration efforts in the Gulf Coast, particularly in Louisiana, as well as the ecological and economic challenges to restoration. He highlights the renewed interest in wetland restoration following both the 2005 hurricanes and the *DWH* oil spill. He summarizes the current practice of habitat equivalency analysis (HEA) to carry out compensatory restoration, and its shortcomings, including the likely main criticism of an HEA: that it may not provide an accurate reflection of the actual costs and benefits of compensatory restoration, because it is based on a *replacement cost* approach to valuation. The points raised by Barbier are particularly important because they highlight the potential flaws in an HEA approach, which currently dominates the NRDA process, and has recently displaced economic valuation as the major approach for damage assessment. He also addresses the key ecological and economic issues that must be addressed for wetland restoration to be successful. With respect to the former, he points out that compensatory damage mitigation, such as wetland banking and compensatory restoration, depends on the principle of ecological equivalence, which may not be achieved in practice. With respect to economics, he points out that the economic literature is severely lacking in terms of quantifying and assessing the economic benefits of ecosystem restoration, especially for aquatic ecosystems.

4.1.3 Fisheries

Alvarez et al. (2014) apply a coarser definition of geographical zones to recreational fishing. This alternative definition still permits substitution between areas potentially affected by an oil spill that is better suited for spills with a large spatial extent. They also develop a quasi-real-time measure of impacts using fishery closure maps that more accurately captures behavioral changes. Asche et al. (2012) extend the use of time series analysis of market integration to the world market for shrimp. One of the key findings relevant to the *DWH* is that they find significant

evidence of integration in the U.S. shrimp market, suggesting that the economic losses in 2010 domestic shrimp production – if in fact caused by the *DWH* spill – was not likely offset by higher prices; rather imports of farmed shrimp increased to satisfy demand.

4.1.4 Real Estate

Winkler and Gordon (2013) introduce the use of monthly event dichotomous variables to measure abnormal property sales volume and prices in a hedonic pricing model. Epley (2012) applies the "before-and-after" procedure to coastal Alabama property, relying on market trends shown in the total population of deed recordings, which allows for the impact of a potential stigma (i.e., an adverse effect on property value produced by the market's perception of increased environmental risk due to contamination) to be estimated.

4.1.5 Household Choice and Perceptions

Several other papers contribute to our understanding of the *DWH* accident on household choices and perceptions. Morgan et al. (2013) take advantage of the natural experiment setting offered by the *DWH* to extend joint revealed-preference / stated-preference models for estimation of both short-term and long-term effects of the spill on consumer demand for oysters. Hamilton, Safford, and Ulrich (2012) conducted a survey of Florida and Louisiana households about changes in their environmental preferences and perceptions as a result of the *DWH* spill. They found that one-fourth of respondents said that their environmental views had changed as a result of the spill. However, the patterns observed tend to reflect differences in the coastlines that shaped their socioeconomic development, with Louisiana respondents less likely to support a deepwater moratorium, alternative energy, or resource conservation.

Farrow and Larson (2012) identify an incremental willingness to pay for news about the Exxon *Valdez* spill and argue how this private value associated with media consumption can be interpreted as a partial measure of social costs for passive viewers who take no further action beyond news viewing and likely represent the majority of affected citizens. Lilley and Firestone (2013) conducted nation-wide household surveys before and after the *DWH* to compare public attitudes regarding offshore oil drilling and offshore wind development. They find that there was a significant drop in support for expanded drilling among coastal

residents but not others. Other papers published since the *DWH* spill that address aspects of the economics of oil spills appear to be motivated not by the *DWH* accident, but rather by the 2002 *Prestige* oil spill in Spain (Alló and Loureiro 2013; León, Arańa, Hanemann, and Riera 2014; Loureiro and Loomis 2013).

5. EMERGING RESEARCH DIRECTION: ECOSYSTEM SERVICES VALUATION

We now turn to a discussion of research topics on the frontier that have gained in prominence as a consequence of the *DWH* accident. The one that appears to have gained the most traction is the integration of ecosystem services valuation into the Natural Resource Damage Assessment (NRDA) process. Boyd (2010) issued a call for this immediately after the *DWH* spill occurred, and this theme was expanded upon greatly in the 2013 report issued by the National Academies (Committee on the Effects of the *Deepwater Horizon* Mississippi Canyon-252 Oil Spill on Ecosystem Services in the Gulf of Mexico), which was influenced heavily by Barbier (2011a). Scarlett and Boyd (2011) expanded the call for ecosystem services valuation to existing federal regulations and programs and Barbier (2013) targeted the call to wetland protection and restoration. These follow on the heels of a growing number of calls for increased use of an ecosystems-based approach to resource management (Bagstad et al. 2012; Committee on Assessing and Valuing the Services of Aquatic and Related Terrestrial Ecosystems 2005; Daily et al. 2009).

The ecosystem services approach differs from traditional valuation approaches in that it focuses not on the value of the resource itself, but on the value of the benefits -- the goods and services -- it provides. The 2004 National Academies report argues that this approach has the potential to change the public's perceptions of natural resources and the way agencies manage them, because it "highlights the ways in which healthy ecosystems support healthy economies." (p. 1) Barbier (2011b) argues that it facilitates a focus on competing uses, such as conservation versus development, and the need to account for the value of ecosystem services to make efficient choices. Specific to damage assessment, Boyd (2010) argues that "lost ecosystem goods and services are the right metric to internalize social costs and make the public whole following a marine pollution or damage incident." (p. 2).

Because with an ecosystems services approach the focus is shifted from the resources themselves to the services provided, it will necessarily change the types of data collected and the means used to collect them. Barbier (2011b) argues that an advantage of viewing coastal/marine ecosystems as capital assets capable of producing goods and services is that it allows application of the standard tools and analysis developed by natural resource economists for modeling these complex systems.

Both Boyd (2010) and Barbier (2011a) point out that with most NRDAs, government trustees have relied on more practical alternatives to the calculation of actual social costs of pollution such as restoration costs, i.e., the expenditures necessary to return a damaged resource to its pre-incident status. (The Exxon *Valdez* case was a prominent exception, where an extensive contingent-valuation survey was used to estimate lost passive-use values.)

The key to successful implementation of an ecosystem services approach to valuation and damage assessment lies in the ability to develop tools capable of demonstrating and measuring causal links between an event such as an oil spill, an injury to the ecosystem, the decrease in services provided by the system, and the value of that decrease. The 2004 National Academies report identifies three major obstacles to successful implementation of an ecosystem services approach. The first is the difficulty in establishing a baseline measurement of goods and services produced by the system just prior to the event. As Boyd (2010) points out in particular for open-sea oil spills such as the *DWH* and the Exxon *Valdez*, the demonstration of causality between a marine accident and economically-meaningful service changes may need to be made over large geographic areas and long time periods. Such relationships are likely to require expensive and data-intensive methods and not likely to be uniform from one location to another.

The second is the difficulty in developing a model that can predict the event's impact on the ecosystem and provide defensible estimates of the magnitude of reduced services. As Barbier (2013) points out, "we often do not know how variation in ecosystem structure, functions, and processes give rise to the change in an ecosystem good or service," (p. 215). Progress is being been made in this regard, however, including the work of Link, Fulton, and Gamble (2010); Pelletier et al. (2009); and Rodwell et al. (2002).

The third is the challenge of establishing capabilities to place economic values on lost services. As both Barbier (2013) and Börger et al. (2014) point out, revealed preference methods such as hedonic and travel cost models are not applicable to many marine ecosystem services, such as those provided by the deep sea, due to a lack of any direct effect on market behavior from which to infer values. Thus, there may be a need for greater reliance on valuation estimates from bio-economic models (e.g., Barbier 2012; Barbier and Lee 2013; Fenichel and Abbott 2014; Finnoff and Tschirhart 2003a, 2003b; Sanchirico and Mumby 2009), or with the use of stated-preference methods, such as contingent valuation and choice experiments (e.g., Bagstad et al. 2012; Bauer, Cyr, and Swallow 2004; Carlsson, Frykblom, and Liljenstolpe 2003; Holmes et al. 2004; Moore, Holmes, and Bell 2011; Loomis et al. 2000; Petrolia, Interis, and Hwang 2014), or contingent behavior, although the latter is geared less to valuation. As Börger et al. (2014) point out, stated-preference methods require careful attention to survey designs to convey meaningful and understandable descriptions of ecosystem services to the general public. It also requires that these descriptions be based on meaningful ecological indicators (Johnston et al. 2012 and Zhao, Johnston, and Schultz 2013). Barbier (2007) compares the production-function and the expected-damage approaches and shows that they yield very different valuations of ecosystems than would be obtained by more typical methods used. He argues that these represent a significant improvement over current practice.

Barbier (2012) and Barbier and Lee (2013) point to another important challenge, which is the ability to capture the spatial variability of ecological production of ecosystem services across specific coastal habitats (such as marsh and mangroves), as well as the "connectivity" of marine habitats (such as mangrove-sea grass-coral reefs) in producing ecosystem services. Barbier (2011b) points out a further challenge: uncertainty about the future values of the services provided. Values may change over time because preferences may change over time or because, as our understanding increases about how these complex ecosystems work, we may come to better appreciate the services provided. Also, continued growth in coastal populations may lead to irreversible increases in resource scarcity, leading to higher values.

Other papers point to additional shortcomings in the literature regarding ecosystem services valuation (Ruckelshaus et al. 2013; Laurans et al. 2013; Pendleton, Atiyah, and Moorthy 2007), and Börger et al. (2014) and Barbier

(2011a) point out a shortcoming specific to wetland and marine habitat valuation: the extremely uneven distribution across habitat types, services, and locations, with most work being done on near-coast provisioning, regulating, and cultural (specifically, recreational) services, such as beaches, fisheries, and coastal properties, and only minimal work on the open ocean and deep sea (e.g., Jobstvogt et al. 2014; Ressurreicão et al. 2011; Wattage et al. 2011). This lack of understanding of the deep sea is echoed by the 2013 National Academies report, particularly because of the recent growth of deepwater oil and gas exploration and production, and of course, the *DWH* disaster.

6. ANOTHER RESEARCH DIRECTION: INJURY TO REPUTATION AS COMPENSABLE DAMAGE

Another direction of research as a consequence of the *DWH* spill is one offered by Larkin, Huffaker, and Clouser (2013), which proposes reduced "place-brand" value of a state, i.e., injury to its reputation, as a recoverable loss under the OPA damages category specifying the "loss of profits or impairments of earning capacity due to the injury, destruction, or loss of real property, personal property, or natural resources, which shall be recoverable by any claimant." They propose a model that interprets a place-brand as a capital asset that generates an income stream by stimulating demand for regional services, such as Florida's reputation for high-quality natural marine-based resources. Assuming an oil spill impairs the value of this place-brand, the difference between user and non-user willingness to pay represents the lost place-brand value during the period of recovery (Larkin, Huffaker, and Clouser 2013). At the household level, something of this effect is captured in the work of Winkler and Gordon (2013), who find that oceanfront condominium prices in Alabama declined not only during the time that health advisories were in effect, but also after they were lifted, suggesting that there still existed a high level of uncertainty regarding the future effects of the spill. Very closely related to this is the issue of liability arising from the deepwater drilling moratorium. Shavell (2011) raises the very important question of whether BP should be liable for economic damages to other firms that were unable to operate due to the moratorium as a consequence of the *DWH* spill. In this context, it is also worth noting the irony of a working paper by Barrage, Chyn, and Hastings (2014) that analyzes how BP's own efforts prior to the *DWH* accident to establish and

maintain a "green" reputation may have softened the blow of "consumer punishment" of BP afterward.

7. DISCUSSION AND CONCLUSIONS

This paper has summarized the sources and levels of funding for economics research stemming from the *DWH* oil spill, the research that has been produced, and an overview of prominent research topics and directions. Based on these findings, it appears that relatively little economic research has been funded by the major sources doling out research funds for the *DWH*. An immediate question is why has economics research apparently been under-funded? A reasonable explanation for why GOMRI has funded very little economics research is that BP probably does not want to fund research that could be used against it in court. One could hardly blame them. To fund research as to the biophysical damages is one thing, but to fund research that has the potential to directly calculate dollar estimates of damages is another. It seems, though, that some reasonable stipulations could have been put in place to restrict any economics research to be "forward looking", i.e., to be geared toward preventing and preparing for the next oil spill rather than estimating damages of the current one. Then again, it is possible that even that kind of research could become a weapon in the hands of the plaintiffs.

A similar rationale may explain why the various state and federal agencies have not produced much or any economics-related impact reports on the *DWH* as they did, for example, after both Hurricanes Katrina/Rita and Sandy. For example, Louisiana Sea Grant provides links to two economic impact assessments for Hurricane Katrina (fisheries losses and resource damages) on their website, but nothing similar for the *DWH*. Instead, only general descriptions of the NRDA process are provided. Also, the U.S. Economics and Statistics Administration, a division of the Department of Commerce, published an impact assessment of Katrina in 2008 (actually 6 versions of it) (USESA 2008) as well as an economic impact study a year after Hurricane Sandy (USESA 2013). For the *DWH*, however, they issued a report on the impacts of the moratorium, but not on the spill itself. NOAA-NMFS published reports on fisheries impacts due to Hurricane Katrina (before *DWH*) and Hurricane Sandy (after *DWH*), but the NMFS oil spill site (and other web searches) brings up no such report for the *DWH*. Here, too, a reasonable explanation comes to mind: if mistakes are made on estimating damages after a

hurricane, there are no real consequences (other than embarrassment for the agency and researcher), but with an oil spill, getting the numbers right is critical to the outcome of the NRDA and litigation processes. So state and federal agencies may not want to stick their neck out at the risk of making a mistake, and instead leave such work to the "experts" involved in the NRDA process. The problem with this approach is that it appears that the NRDA process may have moved away from economic valuation of damages altogether (Barbier 2011a). Only time will tell if the states have "filled the valuation void" left by the changes in the NRDA process, or if we will end up with very little economic assessment of the damages due to the *DWH* being done at all.

These apparent shortcomings make it all the more troubling that NSF and other major sources of public research dollars did not fund more work for economics on the *DWH* than what it appears to have done up to this point. One would expect NSF to be relatively independent of the politics of the process, and if an event of significance merited economic research then they would fund it, regardless of whether – on the one extreme -- a large amount of funds were already being directed to the NRDA process for valuation – or on the other extreme – that the NRDA process had moved away from economic valuation of damages so that little to no valuation work was being done. Comparing to other significant environmental events in the recent past, NSF issued quite a bit of research funds for economics-related research in response to Hurricane Katrina (38 projects listed under the BCS-SBE division out of 302 total projects funded) although for Super-storm Sandy, NSF appears to have funded only four BCS-SBE projects out of 59[3].

It could be simply that economics research is not viewed as critical relative to many of the other fields that did receive funding after the *DWH*. It is true that economists generally require lower funding levels relative to many of the sciences that require expensive equipment, ship time, and other costly things. But the findings reported here indicate differences well beyond accounting for differences in funding scale. If it is because economics just simply is not perceived as a critical area of research following such events – or as the shift in the NRDA process implies, is perceived as something to be avoided altogether -- then the economics field has its work cut out for it in demonstrating both its importance and its reliability, not only of estimating the value of damages, but also in making

[3]Based on a keyword search for "Katrina" ("Sandy") since 2005 (2012), and deleting projects for which project personnel names included Katrina (Sandy).

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investments to push economic theory and methods further so that we are better prepared to make good policy decisions in the future. It may have been useful had the economics discipline engaged its leading experts in "setting the stage" for what is known, what is needed, laying out the key issues, etc., including where theoretical and methodological advances are needed to better deal with major events like the *DWH*. With the exception of the 2012 AEA symposium updating the contingent-valuation debate, however, it appears that none of the major economics or environmental/natural-resource economics associations or journals organized any symposia or special issues dedicated to the largest accidental marine oil spill in history[4]. This could be because those individuals most likely to make contributions were already engaged in the NRDA and other state litigation processes, and thus unable to contribute. Nevertheless, it seems like an opportunity for the economics discipline to contribute to the discussion was missed.

Perhaps the best days are ahead. Perhaps some of the remaining $325 million of GOMRI funds will end up going toward economics research. It is also hoped that some funding will go toward economics research via the individual state research centers of excellence mandated to be established using a portion of RESTORE Act funds. In terms of research outputs, it is hoped that more economic research has been stimulated by the *DWH* than what the findings here indicate and that this research will start to show up in the literature in the coming years. It is worth noting that it took over ten years for the results of the Carson et al. (2003) Exxon *Valdez* contingent valuation study to appear in the refereed journal literature. Only time will tell the full story of what the field of economics had to say about the *DWH* spill and what impact the *DWH* had on economics.

In the meantime, it appears that there are three priority areas regarding the economics of large marine oil spills. First, the push to better understand and correct the incentives faced by the oil and gas sector that affect safety, prevention, and clean-up in deepwater needs to continue. Second, if it is true that the NRDA process has moved away from valuation as a means of assessing damages, then the economics discipline needs to make a convincing argument why that was a bad idea, and needs to demonstrate why economic valuation techniques need to be retained as a major part of the process. It appears that the most promising means of

[4]The Vanderbilt Law School did sponsor a conference entitled "Rigs, Risks, and Responsibility", which featured some very prominent economists, and the contents of which were later published as a special issue in the *Vanderbilt Law Review*.

making this case is by demonstrating the advantages of taking an ecosystem service valuation approach to natural-resource damage assessment. Third, given that much of the oil and gas exploration and production activities in the near future will take place in deepwater, the current shortage of research specific to deepwater marine resources needs to be addressed. If additional resources in the economics discipline can be dedicated to addresses these three areas, then we should be in a better position to both reduce the likelihood of such disasters occurring in the future, and, if they should occur, to mitigating the effects and better assessing the damages.

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REFERENCES

Aldy, Joseph E. 2011. "Real-Time Economic Analysis and Policy Development During the BP Deepwater Horizon Oil Spill." *Vanderbilt Law Review* 64(6): 1795-1817.

Alló, Maria and Maria L. Loureiro. 2013. "Estimating a Meta-damage Regression Model for Large Accidental Oil Spills." *Ecological Economics* 86(February): 167-75.

Alvarez, Sergio, Sherry L. Larkin, John C. Whitehead, and Tim Haab. 2014. "A Revealed Preference Approach to Valuing Non-Market Recreational Fishing Losses from the Deepwater Horizon Oil Spill." *Journal of Environmental Management* 145(December): 199-209.

American Economic Association (AEA). 2014. "EconLit" database. http://www.aeaweb.org/econlit/, last accessed July 8, 2014.

Anderson, Robert, Mark A. Cohen, Molly K. Macauley, Nathan Richardson, and Adam Stern. 2011. "Organizational Design for Spill Containment in Deepwater Drilling Operations in the Gulf of Mexico: Assessment of the Marine Well Containment Company (MWCC)." Discussion Paper RFF DP 10-63, Resources for the Future.

Arrow, K., R. Solow, P.R. Portney, E.E. Leamer, R. Radner and H. Schuman. 1993. Report of the NOAA Panel on Contingent Valuation. *Federal Register* 58: 4601–14.

Asche, Frank, Lori S. Bennear, Atle Oglend, and Martin D. Smith. 2012. "U.S. Shrimp Market Integration." *Marine Resource Economics* 27: 181-92.

Bagstad, Kenneth J., Darius Semmens, Rob Winthrop, Delilah Jaworski, and Joel Larson. 2012. "Ecosystem services valuation to support decisionmaking on public lands—A case study of the San Pedro River watershed, Arizona. U.S. Geological Survey Scientific Investigations Report 2012–5251.

Barbier, Edward B. 2007. "Valuing ecosystem services as productive inputs." *Economic Policy* 22(49): 178-229.

Barbier, Edward B. 2011a. "Coastal Wetland Restoration and the *Deepwater Horizon* Oil Spill." *Vanderbilt Law Review* 64(6): 1821-49.

Barbier, Edward B. 2011b. "Progress and Challenges in Valuing Coastal and Marine Ecosystem Services." *Review of Environmental Economics and Policy* 6(1): 1-19.

Barbier, Edward B. 2012. "A spatial model of coastal ecosystem services." *Ecological Economics* 78: 70-9.

Barbier, Edward B. 2013. "Valuing Ecosystem Services for Coastal Wetland Protection and Restoration: Progress and Challenges." *Resources* 2: 213-30.

Barbier, Edward B. and Katherine D. Lee. 2013. "Economics of the Marine Seascape."*International Review of Environmental and Resource Economics* 7(1): 35-65.

Barrage, Lint, Eric Chyn, and Justine Hastings. 2014. "Advertising, Reputation, and Environmental Stewardship: Evidence from the BP Oil Spill." National Bureau of Economic Research Working Paper 19838, January.

Bauer, Dana Marie, Nicole E. Cyr, and Stephen K. Swallow. 2004. "Public Preferences for Compensatory Mitigation of Salt Marsh Losses: a Contingent Choice of Alternatives." *Conservation Biology* 18(2): 401-11.

Börger, Tobias, Nicola J. Beaumont, Linwood Pendleton, Kevin J. Boyle, Philip Cooper, Stephen Fletcher, Tim Haab, Michael Hanemann, Tara L. Hooper, S. Salman Hussain, Rosimeiry Portela, Mavra Stithou, Joanna Stockill, Tim Taylor, and Melanie C. Austen. 2014. "Incorporating ecosystem services in marine planning: The role of valuation." *Marine Policy* 46: 161-170.

Boyd, James. 2010. "Lost Ecosystem Goods and Services as a Measure of Marine Oil Pollution Damages." Discussion Paper RFF DP 10-31, Resources for the Future.

Carlsson, Fredrik, Peter Frykblom, and Carolina Liljenstolpe. 2003. "Valuing wetland attributes: an application of choice experiments." *Ecological Economics* 47: 95-103.

Carson, R.T. 2011. *Contingent Valuation: A Comprehensive Bibliography and History*. Cheltenham, UK: Edward Elgar.

Carson, Richard T. 2012. "Contingent Valuation: A Practical Alternative when Prices aren't Available." *Journal of Economic Perspectives* 26(4): 27-42.

Carson, Richard T. and W. Michael Hanemann. 2005. "Contingent Valuation," in *Handbook of Environmental Economics: Valuing Environmental Changes*, Vol. 2., K.G. Mäler and J.R. Vincent, eds. Amsterdam: North-Holland.

Carson, Richard T., Norman F. Meade, and V. Kerry Smith. 1993. "Introducing the issues." *Choices* 2nd Quarter: 5-8.

Carson, Richard T., Robert C. Mitchell, Michael Hanemann, Raymond J. Kopp, Stanley Presser,and Paul A. Ruud. 2003. "Contingent Valuation and Lost

Passive Use: Damages from the Exxon *Valdez* Oil Spill." *Environmental and Resource Economics* 25: 257-86.

Cohen, Mark A., Madeline Gottlieb, Joshua Linn, and Nathan Richardson. 2011. "Deepwater Drilling: Law, Policy, and Economics of Firm Organization and Safety." *Vanderbilt Law Review* 64(6): 1853-1916.

Committee on Assessing and Valuing the Services of Aquatic and Related Terrestrial Ecosystems. 2004. *Valuing Ecosystem Services: Toward Better Environmental Decision-Making.* Water Science and Technology Board, Division on Earth and Life Studies, National Research Council of the National Academies. Washington, DC: The National Academies Press.

Committee on the Effects of the *Deepwater Horizon* Mississippi Canyon-252 Oil Spill on Ecosystem Services in the Gulf of Mexico. 2013. *An Ecosystem Services Approach to Assessing the Impacts of the Deepwater Horizon Oil Spill in the Gulf of Mexico.* Ocean Studies Board, Division of Earth and Life Studies, National Research Council of the National Academies. Washington, DC: The National Academies Press.

Committee on Responding to Oil Spills in the U.S. Arctic Marine Environment. 2014. *Responding to Oil Spills in the U.S. Arctic Marine Environment.* Ocean Studies Board, Polar Research Board, Division of Life and Earth Studies, Marine Board, Transportation Research Board; National Research Council of the National Academies. Washington, DC: The National Academies Press.

Cooke, Roger M., Heather L. Ross, and Adam Stern. 2011. "Precursor Analysis for Offshore Oil and Gas Drilling: From Prescriptive to Risk-Informed Regulation." Discussion Paper RFF DP 10-61, Resources for the Future.

Daily, Gretchen C., Stephen Polasky, Joshua Goldstein, Peter M Kareiva, Harold A Mooney, Liba Pejchar, Taylor H Ricketts, James Salzman, and Robert Shallenberger. 2009. "Ecosystem services in decision making: Time to deliver." *Frontiers in Ecology and the Environment* 7: 21-8.

Desvousges, William H., Alicia R. Gable, Richard W. Dunford, and Sara P. Hudson. 1993. "Contingent valuation: the wrong tool to measure passive-use losses." *Choices* 2nd Quarter: 9-11.

Diamond, P.A. and J.A. Hausman. 1994. "Contingent Valuation: Is Some Number Better than No Number?" *Journal of Economic Perspectives* 8(4): 45-64.

Elsevier. 2014. "Scopus." http://www.elsevier.com/online-tools/scopus, last accessed July 10, 2014.

Epley, Donald. 2012. "The Gulf Oil Spill and Its Impact on Coastal Property Value Using the Before-and-After Procedure." *Journal of Real Estate Literature* 20(1): 121-37.

Farrow, Scott and Douglas M. Larson. 2012. "News and Social Cost: The Case of Oil Spills and Distant Viewers." *Journal of Benefit-Cost Analysis* 3(4).

Fenichel Eli P. and Joshua K. Abbott. 2014. "Natural Capital: From Metaphor to Measurement." *Journal of the Association of Environmental and Resource Economists* 1(1/2): 1-27.

Finnoff, David and John T. Tschirhart. 2003a. "Protecting an endangered species while harvesting its prey in a general equilibrium ecosystem model." *Land Economics* 79(2): 60-80.

Finnoff, David and John T. Tschirhart. 2003b. "Harvesting in an eight-species ecosystem." *Journal of Environmental Economics and Management* 45(3): 589-611.

Gulf of Mexico Research Initiative (GOMRI). 2014. "General FAQs". http://gulfresearchinitiative.org/about-gomri/faqs/, last accessed July 8, 2014.

Gulf of Mexico Research Initiative (GOMRI). 2013. "Taking Oil Spill Research into the Future with Public Health." http://gulfresearchinitiative.org/taking-oil-spill-research-future-public-health/, last accessed July 8, 2014.

Haab, Timothy C., Matthew G. Interis, Daniel R. Petrolia, and John C. Whitehead. 2013. "From Hopeless to Curious? Thoughts on Hausman's 'Dubious to Hopeless' Critique of Contingent Valuation." *Applied Economic Perspectives and Policy* 35(4): 593-612.

Hamilton, Lawrence C., Thomas G. Safford, and Jessica D. Ulrich. 2012. "In the Wake of the Spill: Environmental Views along the Gulf Coast." *Social Science Quarterly* 93(4): 1053-64.

Hanemann, W.M. 1994. "Valuing the Environment through Contingent Valuation." *Journal of Economic Perspectives* 8(4): 19-43.

Hanson, Terry and Jeana Baker. 2011. "Gulf Coast Extension Service Oil Spill Recovery Project: Alabama." Progress Report II, October 16, 2010-January 15,2011http://www.aces.edu/dept/fisheries/aquaculture/marine-assessment/documents/GulfQ2FINAL.pdf, last accessed July 10, 2014.

Hausman, J.A. 1993. *Contingent Valuation: A Critical Assessment*. Amsterdam: North Holland.

Hausman, J.A. 2012. "Contingent Valuation: From Dubious to Hopeless." *Journal of Economic Perspectives* 26(4): 43-56.

DOI: 10.15351/2373-8456.1002

Holmes, Thomas P., John C. Bergstrom, Eric Huszar, Susan B. Kask, and Fritz Orr III. 2004. "Contingent valuation, net marginal benefits, and the scale of riparian ecosystem restoration." *Ecological Economics* 49: 19 – 30.

IEM. 2010. "A Study of the Economic Impact of the Deepwater Horizon Oil Spill." A report prepared for Greater New Orleans, Inc. October.

Jobstvogt, N., N. Hanley, S. Hynes, J. Kenter, and U. Witte. 2014. "Twenty thousand Sterling under the sea: estimating the value of protecting deep-sea biodiversity." *Ecological Economics* 97: 10-19.

Johnston, Robert J., Eric T. Schultz, Kathleen Segerson, Elena Y. Besedin, and Mahesh Ramachandran. 2012. "Enhancing the Content Validity of Stated Preference Valuation: The Structure and Function of Ecological Indicators." *Land Economics* 88(1): 102-20.

Kling, C.L., D.J. Phaneuf, and J. Zhao. 2012. "From Exxon to BP: Has Some Number Become Better than No Number?" *Journal of Economic Perspectives* 26(4): 3-26.

Larkin, Sherry L., Ray G. Huffaker, and Rodney L. Clouser. 2013. "Negative Externalities and Oil Spills: A Case for Reduce Brand Value to the State of Florida." *Journal of Agricultural and Applied Economics* 45(3): 389-99.

Laurans, Y., A. Rankovic, R. Bille, R. Pirard, L. Mermet. 2013. "Use of ecosystem services economic valuation for decision making: questioning a literature blindspot." *Journal of Environmental Management* 119: 208-19.

León, Carmelo J., Jorge E. Arańa, Michael W. Hanemann, and Pere Riera. 2014. "Heterogeneity and Emotions in the Valuation of Non-use Damages Caused by Oil Spills." *Ecological Economics* 97(January): 129-39.

Lilley, Jonathan and Jeremy Firestone. 2013. "The Effect of the 2010 Gulf Oil Spill on Public Attitudes toward Offshore Oil Drilling and Wind Development." *Energy Policy* 62(November): 90-8.

Link, J.S., E.A. Fulton, and R.J. Gamble. 2010. "The northeast US application of ATLANTIS: a full system model exploring marine ecosystem dynamics in a living marine resource management context." *Progress in Oceanography* 87(1-4): 214-34.

Loomis, John, Paula Kent, Liz Strange, Kurt Fausch, and Alan Covich. 2000. "Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey." *Ecological Economics* 33: 103–17.

Loureiro, Maria L. and John B. Loomis. 2013. "International Public Preferences and Provision of Public Goods: Assessment of Passive Use Values in Large Oil Spills." *Environmental & Resource Economics* 56: 521-34.

Mendelssohn, Irving A., Gary L. Anderson, Donald M. Baltz, Rex H. Caffey, Kevin R. Carman, John W. Fleeger, Samantha B. Joye, Qianxin Lin, Edward Maltby, Edward B. Overton, and Lawrence P. Rozas. 2012. "Oil Impacts on Coastal Wetlands: Implications for the Mississippi River Delta Ecosystem after the *Deepwater Horizon* Oil Spill." *BioScience* 62(6): 562-74.

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

Moore, Christopher C., Thomas P. Holmes, and Kathleen P. Bell. 2011. "An attribute-based approach to contingent valuation of forest protection programs." *Journal of Forest Economics* 17(1): 35-52.

Morgan, O. Ashton, John C. Whitehead, William L. Huth, Gregory S. Martin, and Richard Sjolander. 2013. "Measuring the Impact of the BP *Deepwater Horizon* Oil Spill on Consumer Behavior: Evidence from a Natural Experiment." Department of Economics Working Paper Number 13-11, April. Appalachian State University.

Muehlenbachs, Lucija, Stefan Staubli, and Mark A. Cohen. 2013. "The Effect of Inspector Group Size and Familiarity on Enforcement and Deterrence." Discussion Paper RFF DP 13-36, Resources for the Future.

National Oceanic and Atmospheric Administration (NOAA). 2014. "Sea Grant Projects (Beta)"database. http://seagrant.noaa.gov/WhatWeDo/Projects.aspx, last accessed July 8, 2014.

Office of Management and Budget. 2014. "USASpending.gov" database. http://www.usaspending.gov/, last accessed July 8, 2014.

Oxford Economics. 2010. "Potential Impact of the Gulf Oil Spill on Tourism." A report prepared for the U.S. Travel Association. July.

Pelletier, D., S. Mahevas, H. Drouineau, Y. Vernard, O. Thebaud, O. Guyader, and B. Poussin. 2009. "Evaluation of the bioeconomic sustainability of multi-species multi-fleet fisheries under a wide range of policy options using ISIS-fish." *Ecological Modeling* 220(7): 1013-33.

Pendleton, L., P. Atiyah, and A. Moorthy. 2007. "Is the non-market literature adequate to support coastal and marine management?" *Ocean and Coastal Management* 50(5-6): 363-78.

Petrolia, Daniel R., Matthew G. Interis, and Joonghyun Hwang. 2014. "America's Wetland? A National Survey of Willingness to Pay for Restoration of Louisiana's Coastal Wetlands." *Marine Resource Economics* 29(1):17-37.

Portney, P.R. 1994. The Contingent Valuation Debate: Why Economists Should Care. *Journal of Economic Perspectives* 8 (4): 3-17.

Posadas, Benedict C. and Benedict Kit A. Posadas, Jr. 2013. "Estimation of the Baseline for Assessment of Economic Impacts of the Gulf of Mexico Oil Spill on Mississippi's Commercial Fishing Sector." Mississippi Agricultural & Forestry Experiment Station Bulletin 1204. May.

Randall, Alan. 1993. "Passive-use values and contingent valuation – valid for damage assessment." *Choices* 2nd Quarter: 12-15.

Randall, A., B. Ives, C. Eastman. 1974. "Bidding Games for Valuation of Aesthetic Environmental Improvements." *Journal of Environmental Economics and Management* 1(2): 132-49.

Research Papers in Economics (RePEc). 2014. "IDEAS" database. http://ideas.repec.org/, last accessed July 8, 2014.

Ressurreicão, A., J. Gibbons, T.P. Dentinho, M. Kaiser, R.S. Santos, G. Edward-Jones. 2011. "Economic valuation of species loss in the open sea." *Ecological Economics* 70(4): 729-39.

Rodwell, Lynda D., Edward B. Barbier, Callum M. Roberts, and Timothy R. McClanahan. 2002. "A model of tropical marine reserve-fishery linkages. *Natural Resource Modeling* 15(4): 453-86.

Ruckelshaus, M., E. McKenzie, H. Tallis, A. Guerry, G. Daily, P. Kareiva, S. Polasky, R.

Taylor, N. Bhagabati, S.A. Wood, and J. Bernhardt. 2014. "Notes from the field: lessons learned from using ecosystem service approaches to inform real-world decisions." Forthcoming, *Ecological Economics.*

Sanchirico, James N. and Peter J. Mumby. 2009. "Mapping ecosystem functions to the valuation of ecosystem services: implications of species-habitatassociations for coastal land-use decisions." *Theoretical Ecology* 2(2): 67-77.

Scarlett, Lynn and James Boyd. 2011. "Ecosystem Services: Quantification, Policy Applications, and Current Federal Capabilities." Discussion Paper RFF DP 11-13, Resources for the Future.

Shavell, Steven. 2011. "Should BP Be Liable for Economic Losses Due to the Moratorium on Oil Drilling Imposed After the Deepwater Horizon Accident?" *Vanderbilt Law Review* 64(6): 1995-2008.

Sumaila, U. Rashid, Andrés M. Cisneros-Montemayor, Andrew Dyck, Ling Huang, William Cheung, Jennifer Jacquet, Kristin Kleisner, Vicky Lam, Ashley McCrea-Strub, Wilf Swartz, Reg Watson, Dirk Zeller, and Daniel Pauly. 2012. "Impact of the *Deepwater Horizon* well blowout on the economics of US Gulf fisheries." *Canadian Journal of Fisheries and Aquatic Sciences* 69: 499-510.

Upton, Harold F. 2011. "The Deepwater Horizon Oil Spill and the Gulf of Mexico Fishing Industry." Congressional Research Service Report for Congress 7 5700. February 17.

Viscusi, W. Kip and Richard J. Zeckhauser. 2011. "Deterring and Compensating Oil-Spill Catastrophes: The Need for Strict and Two-Tier Liability." *Vanderbilt Law Review* 64(6): 1717-65.

Wacker, H. 1999. "Optimal harvesting of mutualistic ecological systems." *Resource and Energy Economics* 21(1): 89-102.

Wattage, P., H. Glenn, S. Mardle, T. Van Rensburg, A. Grehan, and N. Foley. 2011. "Economic value of conserving deep-sea corals in Irish waters: a choice experiment study on marine protected areas." *Fisheries Research 1*07(1-3): 59-67.

Winkler, Daniel T. and Bruce L. Gordon. 2013. "The Effect of the BP Oil Spill on Volume and Selling Prices of Oceanfront Condominiums." *Land Economics* 89(4): 614-31.

Zhao, Minjuan, Robert J. Johnston, and Eric T. Schultz. 2013. "What to Value and How? Ecological Indicator Choices in Stated Preference Valuation." *Environmental and Resource Economics* 56: 3-25.

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