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Public ocean literacy in the United States

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Abstract

The 2004 Pew Ocean Commission report suggests a need to improve public literacy about oceans. The authors of the report assume that enhancing public awareness and knowledge of oceans will lead to increased public support for ocean restoration efforts. Following this line of reasoning, our study investigates current levels of public knowledge and informedness concerning oceans, and also explores the correlates of knowledge holding. Using data gathered from a national random sample of 1233 citizens in Summer/Fall 2003, two hypotheses—trans-situational and situation-specific—are examined as explanations of public knowledge levels concerning ocean policy issues. The trans-situational hypothesis evaluates socioeconomic status (SES) as an explanation for levels of knowledge. The situation-specific hypothesis evaluates personal experiences and contexts that might overcome SES characteristics. We also examine the effect of information source use on knowledge holding. Findings suggest that both trans-situational and situation-specific hypotheses are useful in explaining knowledge levels. We also find that information sources, such as newspapers and the internet, are likely to improve citizen knowledge on ocean issues, while television and radio have a negative effect.

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1. Introduction

On April 20, 2004, the 16 member Oceans Commission, appointed by President Bush, issued a report detailing the deteriorating condition of the nation's coastal waters. The Commission's chairman, Adm. James Watkins, commented at the release of the report: "Our oceans and coasts are in serious trouble" [1, p. A-15]. The Commission's report, along with numerous other studies including the recently released Pew Oceans Commission report *America's Living Oceans: Charting a Course for Sea Change,* argue for new approaches and actions to mitigate and correct these deteriorating conditions. Along these lines, the Pew Oceans Commission called for "a new era of ocean literacy that links people to the marine environment" [2, p. 91]. The Commission further argues that there is a "need to provide the public with understandable information about the structure and functioning of coastal and marine ecosystems, how ecosystems affect daily lives, and how we affect ecosystems" [2, p. 11]. Similarly, the Report of the US Commission on Ocean Policy states: "To successfully address complex ocean- and coastal-related issues, balance the use and conservation of marine resources, and realize future benefits of the ocean, an interested, engaged public is essential" [3, p. 85]. Doug Daigle echoes this call for greater public involvement in coastal conservation, "the only hope for further progress on environmental protection and sustainable development lies with a public that is not only informed but also engaged" [4, p. 230].

Knowledge is vital in developing an individual's perception of the oceans and the resources they provide. Additionally, knowledge is a key component in accomplishing effective environmental policies [5–7]. As Janicke comments, "without a doubt, environmental knowledge and public awareness are important factors influencing environmental policy and management" [8, p. 11]. Because citizens are either directly or indirectly involved in activities and behaviors that may place our ocean and coastal areas at risk, it is indeed important to assess the scope and depth of policy-relevant knowledge among the public and to learn where people tend to acquire their information about ocean and coastal conditions.

It is also important to investigate potential variations in knowledge holding between coastal and noncoastal regions. As the Pew Oceans Commission Report [2] argues, all regions of the country contribute to the deteriorating conditions on our coasts and oceans (e.g., nonpoint source pollution, air pollution, fish consumption, etc.). However, with over half of the nation's population now residing in coastal states, it is imperative to know the levels of knowledge evident among these communities that most directly affect coastal ecosystems. Therefore, this study will examine levels and correlates of policy-relevant knowledge among citizens in both coastal and non-coastal states.

With an understanding of the depth and breadth of knowledge holding, along with the information sources leading to higher levels of knowledge among citizens, more effective public education and information dissemination efforts may be targeted. Therefore, the major objectives of this research are to investigate the level and correlates of policy-relevant knowledge concerning ocean and coastal management issues, and to determine which information sources are associated with higher levels

of policy-relevant knowledge relating to coastal areas and oceans. Data utilized in this study are from a national public opinion survey conducted during the Fall of 2003. This study replicates a 2002 survey of Pacific Northwest citizens and their level of policy-relevant knowledge concerning ocean fisheries issues [9].

2. Public knowledge and oceans

Increasingly the scientific and technical complexity of many public policy issues—such as environmental issues concerning coastal areas and the oceans—poses serious challenges for the effective participation of citizens in the democratic process [6,9,10]. In order for citizens to effectively monitor policy-makers in democratic societies, they need to be informed consumers of relevant scientific research and the policy options suggested by those findings [11,12]. As Beierle and Cayford have argued, "Increasing public understanding of environmental problems builds capacity for solving those problems" [5, p. 15]. However, the critical gap between the need for policy-relevant knowledge and the generally poor level of public understanding of many public policy issues has led some commentators to proclaim the existence of a "legitimacy crisis" [13]. As Mondak points out, "popular input into government will be vacuous if citizens fail to…comprehend the intricacies of policy debates" [14, p. 513].

Many scholars suggest that knowledge is central to the policy-making process and that improving the knowledge base of citizens should be the first step in establishing a nation-wide effort to preserve the oceans. Eagly and Kulesa have argued "communications directed to the general public are important not only because they may influence public opinion, and therefore have an impact on public policy, but also because they are potentially effective in inducing individuals to engage in behavior that can lessen the destructive impact of humans on the environment" [15, p. 123]. In fact, McKenzie-Mohr [16] has identified the lack of knowledge as a major reason for public non-involvement in environmental activities.

This call for a knowledgeable public has been made in the area of coastal and ocean issues as well. For example, the official report of the Independent World Commission on the Oceans, chaired by Mário Soares ("The Ocean: Our Future") called for the development of a "comprehensive strategy for public awareness to improve citizen awareness of ocean policies" [17]. Alan I. Leshner, Chief Executive Officer of American Association for the Advancement of Science (AAAS) and Executive Publisher of *Science* has further argued "the public is deeply concerned about the environmental challenges facing our oceans and coastal regions and, given information and a voice in the discussion, is willing to back up that concern with personal action" [18].

Previous research on public knowledge concerning ocean conditions has revealed that while there is a general realization that ocean and coastal areas are in trouble due to pollution, over-fishing, etc., the public knows little about ocean functions and ecology. For example, a 1999 survey conducted by The Ocean Project has revealed [19, p. 1]:

> Americans possess a superficial knowledge of the oceans. The public knows generally that the oceans are essential to human survival and that we need to protect them. However, many are unaware of the specific functions of the oceans and their part in damaging the health of the oceans.

A survey conducted by the Coral Reef Foundation and SeaWeb in 2002 exhibited similar findings, with most Americans expressing concern about coral reefs but also revealing low levels of knowledge concerning the reefs themselves [20]. A 2003 survey commissioned by the AAAS also found widespread concern among the public for coastal regions and ocean health, but also found that only 31 percent of respondents knew their personal behaviors had an impact on the health of oceans and coastal areas [18]. Similarly, a 2002 study of citizens in the Pacific Northwest found citizens expressing much concern about ocean and coastal conditions, but also revealing low levels of policy-relevant knowledge concerning ocean and coastal issues among many citizens [9]. This study also found a strong relationship between knowledge holding and support for protection and restoration of ocean fisheries. Those citizens exhibiting higher levels of policy-relevant knowledge were significantly more likely than the least knowledgeable to support restoration efforts [9, p. 49]. Therefore, it is important to investigate potential explanations of the ocean "knowledge" gap in order to develop approaches to close the gap.

3. Correlates of policy-relevant knowledge

As we have discussed above, there are many social and natural scientists, along with many policy makers, who argue that knowledge enhances the ability of individuals to understand and recognize environmental issues in general and ocean issues more specifically. Much research concerning the distribution of public knowledge in various areas of public policy has documented a "knowledge gap" separating persons of lower and higher socioeconomic status (SES) [7,11]. Lower SES individuals typically have significantly lower levels of policy-relevant knowledge when compared to those of higher SES [21–23]. As Tichenor, Donohue and Olien argue, "as the infusion of mass media information into a social system increases, segments of the population with higher socioeconomic status tend to acquire this information at a faster rate than lower status segments, so that the gap in knowledge between these segments tends to increase rather than decrease" (cited in [21, p. 437; 24, p. 159–160].

There are two theories that have been proposed to explain the knowledge gap separating higher and lower SES citizens. The first theory focuses on "trans-situational" conditions associated with lower SES status, such as level of formal education, income, and occupation [25]. All three of these variables have been found to strongly correlate with environmental knowledge holding in the United States, Canada, Japan, and Russia [7,11,26]. Gender and age also have been found to be important correlates of knowledge, with youth and women exhibiting lower levels of knowledge when compared to older cohorts and men [11,27,28].

If low levels of knowledge concerning ocean and coastal issues is a product of trans-situational factors alone, the prospects for increasing knowledge levels with public information and media campaigns may be limited due to the relatively static nature of these factors [11]. However, if low levels of knowledge can be explained by a second theory of "situation-specific" factors, there is more hope that outreach efforts may be successful. This second theory suggests that even when controlling for SES characteristics, situational indicators will exhibit independent effects on knowledge holding [26,29]. Situational factors are motivational in character in that their presence leads to the acquisition of information by citizens irrespective of their SES characteristics. According to this approach, knowledge seeking and knowledge holding is highest among individuals who see a particular stake in policy outcomes [28], among those who are strongly committed to their policy views [7], and among those who discuss such issues frequently [11]. For example, one might expect higher levels of knowledge concerning oceans and coastal management issues among those citizens who frequently visit or live in coastal areas for either recreation or commercial purposes , and among those who have strong attitudes about ocean and coastal management issues (e.g., environmentalists). Cicin-Sain and Knecht have argued along these lines [30, p. 24]:

> People inhabiting the coastal zone are apt to see the ocean and its resources in more immediate and more tangible terms than does the inland population. Not surprisingly, these interests are likely to involve (1) economic consideration such as earning a living, (2) having a high quality environment, and (3) having an influence over government decisions that affect the coastal population.

3.1. Information sources

In addition to knowing the trans-situational and situation-specific correlates of policy-relevant knowledge, it is also important to determine which information sources are associated with higher levels of policy-relevant information. Previous research has shown that citizens' can use many information sources for policy-relevant information, and that the scope of sources tapped is dependent on a number of factors [26,31]. Those factors include personal (e.g., education), cognitive (e.g., information base), and affective (e.g., ideological orientation) attributes of the individual and the substantive content of the particular policy area [7,32].

According to Brians and Wattenberg, "…the mass media are widely recognized as providing the primary sources of political information for most citizens" [33, p. 172]. Television has been identified as the most used source for information—especially environmental information—even though most citizens and social scientists question the reliability of information provided [7,27,31,34]. As Mondack has argued [14, p. 514]:

> Television is one of the alleged culprits responsible for low levels of political knowledge in the United States. Newspapers, the argument goes, are relatively

well suited to convey information about politics, but the growing significance of television has numbed the minds of Americans.

Research conducted by Steger et al. [32] and Pierce et al. [7] found a negative relationship between television use and environmental knowledge in Michigan. Similarly, television use was also negatively correlated with ocean knowledge in a recent study conducted in the Pacific Northwest [9]. Newspaper use, on the other hand, was positively correlated with policy-relevant knowledge in both the Michigan and Pacific Northwest studies. This finding is consistent with most other research showing a positive relationship between newspaper readership and knowledge holding in general [27,33].

Additional information sources where people can learn about ocean and coastal issues include the internet and radio. Concerning the internet and its impact on knowledge holding, the results are mixed. The range of possible information sites on the web is enormous; however, the quality of sites is mixed at best [35]. While some internet sites are highly informative and useful sources of policy-relevant information, others are unreliable [36,37]. Norris and Jones [38] argue that when the internet is used for information and communication, it can have a very beneficial impact on citizens' roles in public affairs, whereas when it is used for entertainment and recreation it may actually erode citizen participation in public affairs, much like television. Therefore, it would appear that the internet is rather like all other information sources—they can either inform or misinform users. There are, however, excellent sources of information on the internet concerning ocean and coastal issues including those of many Sea Grant programs in the United States.

As with the internet, radio can be used for a diverse set of purposes ranging from the transmission of educational programming such as that often featured on National Public Radio (NPR) to the airing of various "talk shows" catering to ideologues. Lee and Cappella have found when a radio audience is "exposed to an intense, one-sided message, their agreement with the positions advocated increases as exposure and reception increase" [39]. They also found that the public typically selects radio programs that are consistent with their own partisan predispositions, which then reinforces their existing political attitudes and beliefs. Research reported by Steger et al. [32] found that radio use is positively correlated with environmental knowledge in Canada, but in the American context it had a negative impact on knowledge holding. Research conducted by Delli Carpini and Keeter [11] found that radio use has a slightly positive effect on general political knowledge. Therefore, as with the internet, the capacity of radio to increase knowledge concerning oceans and coastal areas is mixed.

4. Methodology

The findings reported here are derived from a survey conducted between July and September 2003 among a random national sample of households in the 48 contiguous states. Each contacted household was issued the following request for

participation: "If available, we would prefer the person, 18 years old or older, who most recently celebrated a birthday to complete the survey." Three waves of mail surveys were distributed, followed by subsequent telephone reminders if necessary (we also encouraged non-respondents to provide their responses over the phone). A total of 1233 completed surveys were collected in this period, and a 56 percent response rate was achieved by the use of the multiple contact survey design. As with all surveys, question wording, refusals, and other difficulties encountered in the implementation of surveys can result in some measurement error or unintended bias in responses. However, the use of mail surveys in this project provides respondents sufficient time to read and reflect upon the intent and wording of each question before responding. In the forthcoming analyses we present the results for the entire national sample, along with data for coastal and non-coastal states. For this study, we define coastal states as those states that border the Pacific and Atlantic Oceans and the Gulf of Mexico. While the Great Lakes states are also considered coastal states, the knowledge questions utilized in this study concern mostly ocean issues specifically.

5. Public knowledge of ocean and coastal issues

In order to assess the level of ocean and coastal knowledge evident among citizens, we used three general indicators that were originally developed and tested in a study conducted in Oregon [9]. The first indicator is a general self-assessed level of informedness, which asked respondents: "In general, how well informed would you consider yourself to be concerning ocean and coastal policy issues—such as fisheries, beach erosion, pollution, etc.—in the United States?" The response scale provided ranged from 1 = not informed to 4 = very well informed (see Table 1). The next two indicators used were based on a review of numerous websites directly concerned with public education on ocean and coastal issues. These sites included, but were not limited to, the NASA-sponsored site *Ocean World at Texas A&M* (oceanworld.tamu.edu) and the *National Marine Fisheries Service, Pacific Fisheries Environmental Laboratory* (www.pfeg.noaa.gov/research/climatemarine/). From these sites we

Table 1
Self assessed level of informedness with ocean and coastal policy issues

	Total (%)	Coastal states (%)	Non-coastal states (%)
1. Not informed	33.5	29.3	38.2
2. Somewhat informed	52.2	56.3	51.9
3. Informed	10.0	11.0	8.9
4. Very well informed	4.3	3.4	1.0
N	1223	639	589
Chi-square = 17.42			
$p \leqslant 0.001$			

constructed a list of topics considered important for the public to know. Next, more than 20 university and government agency scientists (including social, natural and extension scientists) currently involved in ocean and coastal resource management research were asked to identify which of these topics they considered most important for citizens to know about at the present time. Based on these interviews, we next developed two types of indicators of knowledge—one subjective (see Table 2) and the other objective (see Table 3).

The indicator of subjective knowledge holding is based upon asking survey respondents to indicate their level of *familiarity* with a number of specific terms and concepts commonly encountered in the discussion of coastal and ocean management issues by parties engaged in the public policy process. The indicator of objective knowledge holding is based on asking respondents a series of multiple-choice questions concerning ocean and coastal management issues. Both of these indicators were previously used in a public survey conducted in Oregon and were found to be robust indicators of public knowledge concerning coastal and ocean issues [9].

The frequency distributions associated with all three knowledge indicators are displayed in Tables 1–3. In regard to the first indicator of general informedness, we find that very few residents of coastal and non-coastal states consider themselves "informed" or "very informed." However, residents of coastal states were significantly less likely than non-coastal states to say they were "not informed" (29.3 and 38.2 percent respectively; see Table 1). Overall, one could interpret these

Table 2
Familiarity with ocean and coastal management terms

Term Familiarity: For the following terms, please indicate if you know what the term means, have heard of the term but don't know its meaning, or have not heard of the term at all.

		Percent say "know" term	
	Total (%)	**Coastal states (%)**	**Non-Coastal states (%)**
a. Ecosystem	82.4	84.7	79.9
b. Marine protected area	71.3	75.1	67.1
c. Non-indigenous species	64.7	69.1	59.9
d. Biodiversity	56.7	59.2	54.7
e. Gill net	53.4	57.1	49.3
f. Mixed-stock fisheries	51.0	54.8	46.8
g. Rockfish	48.6	57.1	39.3
h. Nonpoint source pollution	28.3	27.7	29.0
i. Exclusive economic zone	23.6	25.6	21.4
j. Coastal zone management act	20.2	22.3	18.0
k. Anadromous	10.4	13.0	7.6
l. Magnuson–Stevens fish Conservation act	5.1	5.6	4.6
Average number of TERMS known	5.11	5.53	4.67
N	1106	567	539
t-test = 26.68 $p \leqslant 0.001$			

Table 3
Public ocean quiz scores by region

Term familiarity: For the following terms, please indicate if you know what the term means, have heard of the term but don't know its meaning, or have not heard of the term at all [highest percent correct = **boldface**]. ***Ocean Quiz*** [answers are ***boldface***]	**Total (%)**	***Percent correct answer***	
		Coastal state (%)	**Non-coastal state (%)**
a. Ocean fisheries are affected by [climate change; red tides; over-fishing; **all of the above**]	73.7	74.2	72.8
b. Most sea life [**lives in the top 500 ft of the ocean**; lives on the sea floor; lives in the great ocean basins; is evenly dispersed throughout the ocean depths]	41.7	43.6	39.6
c. The movement of cold, nutrient-rich water to the surface of the ocean is referred to as [**upwelling**; southern oscillation; trade winds; reversal tide]	40.8	41.6	39.9
d. The phenomenon known as El Niño [commonly occurs around Christmas time every 4–7 years; is indicated by a warming of the waters off the coast of Peru; is indicated by a slowing down or reversal of the trade winds; **all of the above**]	37.2	37.1	37.4
e. By-catch refers to [regular fish caught by nets; over-fishing; **fish that are harvested, but not sold or kept for personal use**; a climate phenomenon]	29.5	29.7	29.4
Mean number correct on *QUIZ*	2.23	2.26	2.20
N	1210	640	570
t-test = .423 $P \leqslant 0.516$			

results with some concern with slightly more than 14 percent of the entire national sample indicating they are informed and very informed about ocean and coastal policy issues.

For the second subjective knowledge indicator presented in Table 2, respondents were provided with a list of 12 terms and asked to "please indicate if you know what the term means, have heard of the term but don't know its meaning, or have not heard of the term at all." A majority of the entire sample indicated that they "know" six of the terms, and a majority of respondents in coastal states were more likely to indicate they knew more of the terms when compared to respondents in non-coastal states. We constructed a summary index of familiarity with the 12 terms to use in the multivariate analyses (Table 4). For each term a respondent knew they were given a

Table 4
Logistic regression estimates for knowledge indicators[a]

	Self-assessed informedness	Familiarity with terms	Ocean quiz
	Coefficient (Std. error)		
Trans-situational factors			
Age	.005	−.007	.016***
	(.007)	(.004)	(.005)
Gender	−1.074***	−.490***	−.460***
	(.222)	(.136)	(.138)
Education	.269**	.273**	.201***
	(.085)	(.049)	(.052)
Situation-specific factors			
Coast	.209	.225	.105
	(.239)	(.141)	(.144)
	1.01***	.292***	.384***
Visit	(.111)	(.074)	(.078)
NEP	.068***	.069**	.052***
	(.022)	(.015)	(.015)
Information sources			
TV	−1.013***	−.641***	−.334**
	(.231)	(.136)	(.139)
Internet	.639*	.342	.425*
	(.278)	(.207)	(.213)
Radio	.270	−.549***	−.578***
	(.248)	(.167)	(.175)
Newspaper	.079	1.202***	.466**
	(.213)	(.144)	(.145)
Chi-square	195.00***	201.78***	148.11***
% correctly classified	88.8	67.4	65.9
N	1157	1161	1065

*$p \leqslant 0.05$; **$p \leqslant .01$; ***$p \leqslant 0.001$.

[a]The dependent variable for Self-Assessed Informedness was dichotomized with 1 = "informed" and "very informed" and 0 = else; Terms and Quiz were dichotomized with 1 = above average familiarity with Terms/above average score on ocean quiz; and 0 = else.

1, and for those they did not know they were given a 0. The average number of terms known to coastal state respondents was 5.53 and for non-coastal states it was 4.67. As with the self-assessed informedness variable in Table 1, coastal respondents are significantly more likely than non-coastal respondents to indicate higher levels of information as was predicted by Cicin-Sain and Knecht [30].

The third and final knowledge indicator used in this study is based on the number of correct answers recorded to five questions concerning ocean resource issues (see Table 3). As we discussed above, these questions were adapted from an interactive ocean quiz available at the *Ocean World* website identified above. Question wording and potential answers are provided in Table 3. Correct answers for each question are in boldface. Only one question received a large percentage of correct answers, while the remaining four questions received less than 44 percent correct for both coastal and non-coastal states. Over 73 percent for the total sample knew the various factors affecting ocean fisheries (Question "a"), but less than a third of the national sample knew what the term "by-catch" means. One major pattern evident in these results is the lack of difference between coastal and non-coastal respondents. The percentage of correct responses is similar for both sets of respondents. As with the previous knowledge indicator, we constructed a summary index of correct answers for these five questions. Correct responses were given a 1, and incorrect responses were given a 0. The mean scores for coastal and non-coastal states are 2.26 and 2.20, respectively. *t*-test results reveal that there is no statistically significant difference between these two groups of respondents, which is different from the previous two subjective indicators of knowledge and informedness.

To summarize our results for these three subjective and objective indicators of knowledge, a third of respondents considered themselves not informed concerning ocean and coastal policy issues. Respondents familiar with many ocean and coastal management terms, and respondents who could correctly answer the five-item ocean quiz, both averaged under 50 percent correct. Of course, the results could have been much worse. However, we believe these results are consistent with previous research indicating that the public is poorly informed on many ocean and coastal policy issues.

Even if one judges these results as encouraging or positive, there is still considerable room for improvement in the area of public education about ocean and coastal issues. The next section of the study examines those factors—situational, trans-situational, and information source use—that potentially correlate with higher levels of knowledge concerning ocean issues. Our belief is that documenting the correlates of higher levels of knowledge and understanding can lead to more effective public education and information campaigns.

Because the responses to all three knowledge indicators are skewed, each variable was dichotomized for use in multivariate models. The dependent variable for Self-Assessed Informedness (Table 1) was dichotomized with 1 = "informed" and "very informed" and 0 = else; the variables Terms (Table 2) and Ocean Quiz (Table 3) were dichotomized with 1 = above average scores for Familiarity with Terms and Ocean Quiz; and 0 = for below average scores. Logistic regression models are used

to examine the impact of the various trans-situational, situational, and information sources on citizen responses to the three-information/knowledge indicators.

Coding information and measures of central tendency for the various independent variables used to predict scores for the three dependent variables (informedness, terms, and quiz) are provided in the appendix. The situational variables examined as predictors of ocean and coastal knowledge and informedness include age in years, gender, and formal educational attainment.[1] The trans-situational variables examined include a dummy variable for location of the respondent (1 = coastal state; 0 = non-coastal state) as an indicator of issue interest, the frequency of visits to coastal areas,[2] and support for the New Environmental Paradigm (NEP),[3] which is an indicator of environmentalism [40,41]. As suggested previously, we expect higher levels of knowledge concerning oceans and coastal management issues among citizens who live in coastal states, who frequently visit the coast, and among those who have strong attitudes about the environment. Such citizens have an incentive to become informed. Lastly, we examine the effect of mass media information sources the public may use to become informed about ocean and coastal policy. The sources examined include the use (frequency) of radio, television, the internet, and newspapers for information concerning ocean and coastal issues.

For all three models presented in Table 4, the chi-square statistic is significant at the .001 level, indicating that the specified structure constitutes an acceptable model in the statistical sense. In addition, the percent of cases correctly classified by each model ranges from a low of 65.9 percent for Ocean Quiz to 88.8 percent for Self-Assessed Informedness. In general, it appears that our models work well in predicting whether respondent scores on the three knowledge and informedness indicators.

[1]The indicator and response categories used are: What level of education have you completed? (1) grade school, (2) middle or junior high school, (3) high school, (4) vocational school, (5) some college, (6) college graduate, (7) graduate school.

[2]The question and response categories used are: How often, if ever, do you visit or use ocean (salt water) coastal areas for recreation, leisure, or business? (1) never, (2) rarely, no more than once or twice a year, (3) occasionally, several times a year, (4) somewhat frequently, at least once a month on average, (5) very frequently, at least once a week or more.

[3]The measure of environmental attitudes used to predict environmental behavior and participation is Van Liere and Dunlap's NEP indicator [40,41]. The measure of NEP employed contained a subset of six of the 12 items found in the original inventory and has been found to generate results virtually identical to those of the 12-item version. The items are as follows: (1) The balance of nature is very delicate and easily upset by human activities; (2) The earth is like a spaceship with only limited room and resources; (3) Plants and animals do not exist primarily for human use; (4) Modifying the environment for human use seldom causes serious problems; (5) There are no limits to growth for nations like the United States; (6) Humankind was created to rule over the rest of nature. A Likert-type response format was provided for each item, taking the following format: "strongly agree," "agree," "neutral," "disagree," and "strongly disagree." A pro-NEP position consists of agreement on the first three items, and disagreement on the last three items. After recoding items so that higher numbers reflected a biocentric position (NEP) and lower numbers reflected an anthropocentric position (Dominant Social Paradigm), the responses were summed to form an indicator ranging from 6 to 30. The reliability coefficient (Cronbach's alpha) for the NEP was .79, suggesting that respondents were consistent in their response patterns for the additive scale.

For the situational variables included in all three models, we find that gender and education produce statistically significant impacts. Age has a statistically significant impact only in the Ocean Quiz model. As was expected, education has a positive and significant ($p \leqslant 0.001$) impact on knowledge levels. The higher the level of formal educational attainment, the more likely respondents felt informed about ocean and coastal issues and the higher the index score for both the ocean quiz and term familiarity measures of knowledge. As for gender, we found that men were significantly more likely to respond that they are informed about ocean and coastal issues and to have higher scores on both knowledge indicators when compared to women ($p \leqslant 0.001$ level). As was discussed previously, this gender gap in knowledge is consistent with previous research conducted by political scientists concerning political affairs and various issues in public policy. As for the independent impact of age, it only demonstrated a significant effect for the Ocean Quiz model, with older respondents typically having higher scores than younger respondents.

For the three trans-situational variables included in each model, we find significant results for the variables Visit and NEP in all three models. We expected that those respondents who visit the coast frequently (for recreation, leisure or business) would have a stake in learning about coastal and ocean policy issues. The variable assessing frequency of visits to the coast was significant at the $p \leqslant 0.001$ level and positive in all three models, suggesting that indeed frequency of visits has a positive effect on both subjective and objective forms of knowledge holding. Similarly, we expected those respondents who express NEP values to be motivated to acquire information and knowledge concerning coastal and ocean areas. Once again, this trans-situational variable has a positive and significant ($p \leqslant 0.001$ level) effect in all three models, indicating that the more strongly one identifies with the NEP the higher the score for term familiarity and the more items known on the ocean quiz.

The third situation-specific variable—the dummy variable for coastal and non-coastal states—was not significant in any model. Our explanation for this finding is that even though a respondent may live in a coastal state, if they do not visit and take an interest in ocean and coastal issues, then it is probably not a salient issue for them. While our previous bivariate findings indicate slight differences between coastal and non-coastal states concerning two of the knowledge indicators (i.e., Self-Assessed Informedness and Familiarity with Terms), this relationship does not hold for the multivariate analyses. Further analyses revealed that while respondents in coastal states were significantly more likely to visit the coast when compared to non-coastal state residents, there were no statistically significant differences in knowledge levels between coastal and non-coastal state respondents if they were frequent visitors to the coast.

The final set of independent variables used to predict knowledge holding relate to information source use. Four different mass media information sources were included in the three multivariate models. These sources include television, the internet, radio, and newspapers. Respondents were asked to indicate the frequency of use for each source (1 = never to 5 = very frequent). Our findings indicate that several of the information source variables demonstrate a statistically significant connection to the three knowledge and informedness indicators. As previous research has shown, frequent use of television as an information source has a

negative affect on public knowledge levels about ocean and coastal issues for all three models (significant at the .001 level). Similarly, frequent use of radio also has a significant and negative impact in two models—Familiarity with Terms and Ocean Quiz. However, consistent with other research on public knowledge levels, frequent use of newspapers for information is significantly and positively related to higher levels of knowledge with these same two models. Those respondents who frequently use newspapers for information on coastal and ocean issues were significantly more likely to be familiar with ocean and coastal policy terms, and to score higher on the Ocean Quiz. The final mass media indicator included in the models—frequency of internet use—had a significant and positive effect in two models as well. Frequent use of the internet as a source of information led to respondents claiming they were informed about ocean and coastal issues (Self-Assessed Informedness) and to higher scores on the Ocean Quiz.

Our findings concerning the correlates of informedness and knowledge of ocean and coastal issues suggest that both situational and trans-situational variables affect knowledge holding among citizens, and that use of certain information sources can either contribute to knowledge or adversely impact knowledge levels. These survey results suggest that public outreach and education efforts might be most successful if they involved some type of visit or field trip to a coastal area. This could involve both coastal and non-coastal students engaging in ''real oceanographic investigations'' via field and laboratory experiments both on-site or through distance education technologies as recommended by the US Commission on Ocean Policy [3, p. 97].

6. Conclusion

As other studies have suggested, we have found that the public is not well versed on environmental terms and knowledge about ocean issues. While coastal residents say they are slightly more knowledgeable than those residing in non-coastal areas, both coastal and non-coastal respondents have trouble identifying important terms and answering ocean quiz questions. These results do not speak highly to the informedness of the public on ocean issues. The low level of knowledge about ocean issues implies the public needs access to better information delivered in the most effective manner.

In terms of how to deliver information, we found that television and radio have a negative influence on knowledge holding, which has been found in other studies concerning political and public policy knowledge. Newspapers and the internet have a positive overall influence on knowledge holding. However, the frequency of internet use is currently low relative to other media sources, and newspapers are being read less and less as people watch an increasingly diverse mix of television programs. Radio stations play mainly music with a very limited news focus. Talk radio tends to draw people whose minds are already made up while public radio is informative, but is an information source for those already well educated and experienced. Our results suggest that television or radio may not be the most successful method of information delivery.

The survey results point to a need to think of different ways of improving public knowledge. Support for both the trans-situational and situation-specific hypotheses are reflected in our results. Gender and education are the two most important variables supporting the trans-situational hypothesis. Being male and better-educated leads to greater self-reported levels of informedness, better knowledge of ocean terms, and higher scores on the ocean quiz. Future efforts to inform the public on ocean and coastal issues must effectively target women and low SES citizens.

The two most significant situation-specific variables are visiting the coast and having NEP values. Situation-specific factors emphasize experience with the issues and language used to describe them. Experiencing coastal environments and developing environmental values bring people closer to the problems faced in coastal and ocean areas. The underlying message of this study is that more articles in the media may give the illusion of building better knowledge in the public, but these data suggest people need to actually experience the problems before they are likely to change their views.

Appendix. Independent variables

Variable name	Variable description	Mean (std. dev.)
Trans-situational factors		
Age	Respondent age in years (range: 18–91 years)	50.5 (15.9) $n = 1224$
Gender	Dummy variable for respondent gender 1 = female 0 = male	.54 $n = 1218$
Education	Formal educational attainment 1 = grade school to 7 = graduate school	5.08 (1.41) $n = 1222$
Situation-specific factors		
Coast	Dummy variable for household location 1 = coastal state 0 = non-coastal state	.52 $n = 1233$
Visit	Frequency of respondent visits to ocean coastal areas for recreation, leisure or business 1 = never to 5 = very frequently, at least once a week or more	2.37 (1.01) $n = 1229$
NEP	NEP index 6 = Low support for environmental protection to 30 = High support for environmental protection	23.27 (4.49) $n = 1176$

Information sources		
TV	Frequency of use of television for information concerning coasts and oceans 1 = never to 5 = very frequently	3.81 (0.88) $n = 1211$
Internet	Frequency of use of internet for information concerning coasts and oceans 1 = never to 5 = very frequently	1.51 (1.12) $n = 1131$
Radio	Frequency of use of radio for information concerning coasts and oceans 1 = never to 5 = very frequently	1.68 (.98) $n = 1165$
Newspaper	Frequency of use of newspapers for information concerning coasts and oceans 1 = never to 5 = very frequently	2.12 (1.03) $n = 1198$

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