SUPPLEMENTARY MATERIALS

Trends in NSF funding of LTEES

To evaluate trends in the relative investment (awards) in long-term ecological and environmental studies (LTEES) by NSF, we compared the trajectories of the total amount awarded for ecological research (including LTER, excluding workshops, instrumentation and REU) and funding allocated to short-term (≤ 4 year) and long-term (> 4 year) research projects by the Divisions of Environmental Biology (DEB) and Oceanography (OCE) by year from 2004 to 2015. Funding (awards) data were downloaded from http://www.nsf.gov/awardsearch/. Temporal trajectories of the award total, number of awards, and average award size for short-term and long-term studies were compared with an analysis of covariance (ANCOVA).

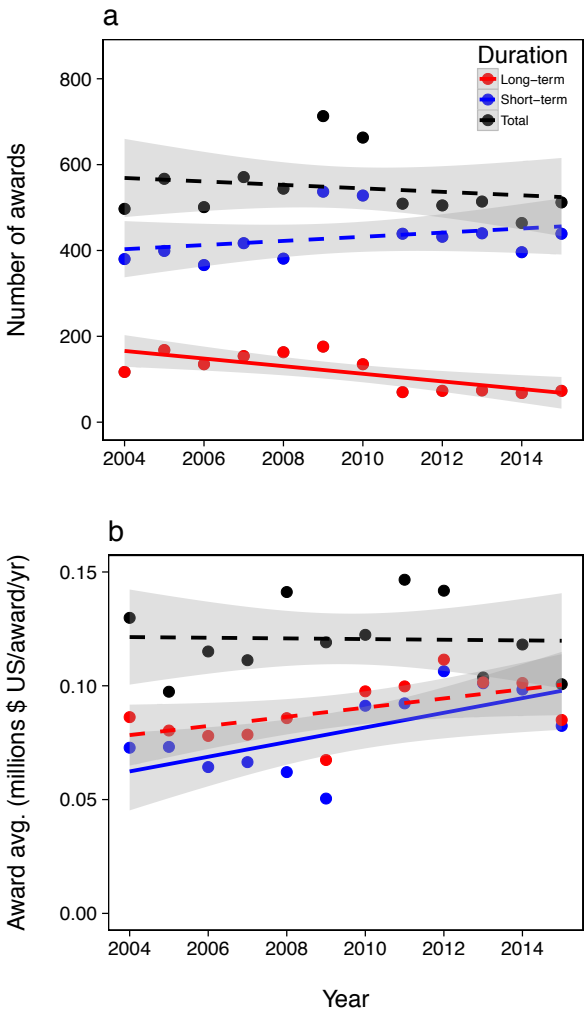

Figure s1. Trends in NSF funding for DEB and Biological Oceanography for (a) number of awards and (b) average award size for short (≤ 4 year) and long-term (> 4 year) study duration, respectively. Solid lines indicate significant trends ($P < 0.05$), dashed lines indicate non-significant trends ($P > 0.05$). Grey areas represent 95% CI.

Error in of study duration estimates: ecological literature

Sixteen individuals reviewed an entire year of publications in 14 and 15 journals from 2006 and 2010, respectively. We determined the error in estimates of study duration among reviewers by comparing duration estimates by two independent observers of a subsample of articles (5%; n = 142) selected at random from both years of the journals. Of the total 18% error in estimates of study duration between observers, 48% was error by a single year (supplementary materials figure s2).

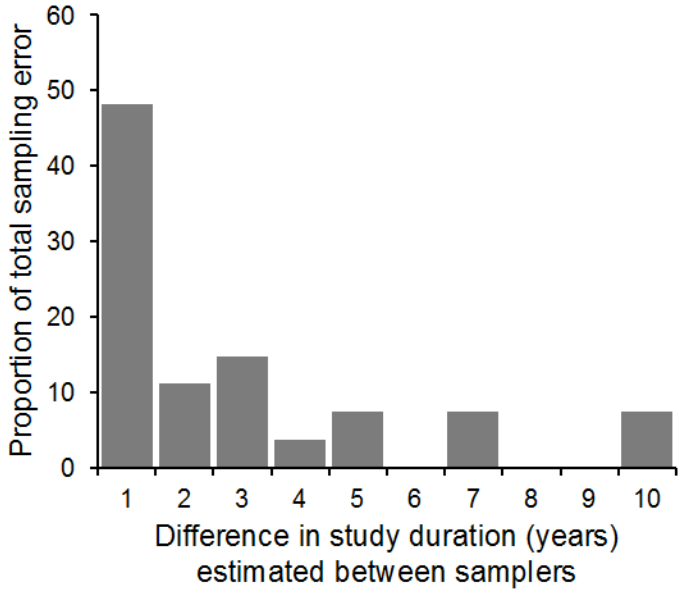

Figure s2. Results from a resampling estimate of reviewer error in estimates of study duration.

Categorization of LTEES

We assessed LTEES both as a continuous variable (e.g., mean study duration) and categorically by defining LTEES as study durations greater than 4 years. We chose this delineation to distinguish LTEES from study durations typical of both doctoral dissertations and individual NSF awards (typically four years or less). We evaluated the effect of this choice on the results of our analyses by comparing the slope of relationships between journal impact factor and percent LTEES using LTEES definitions of 5 to 10 year durations with an analysis of covariance (ANCOVA). Slopes of these relationships did not differ significantly for either 2006 (Duration * Impact Factor interaction: $F = 0.093$; $df = 5,72$; $P = 0.993$) or 2010 ($F = 0.442$, $df = 5,78$; $P = 0.818$).

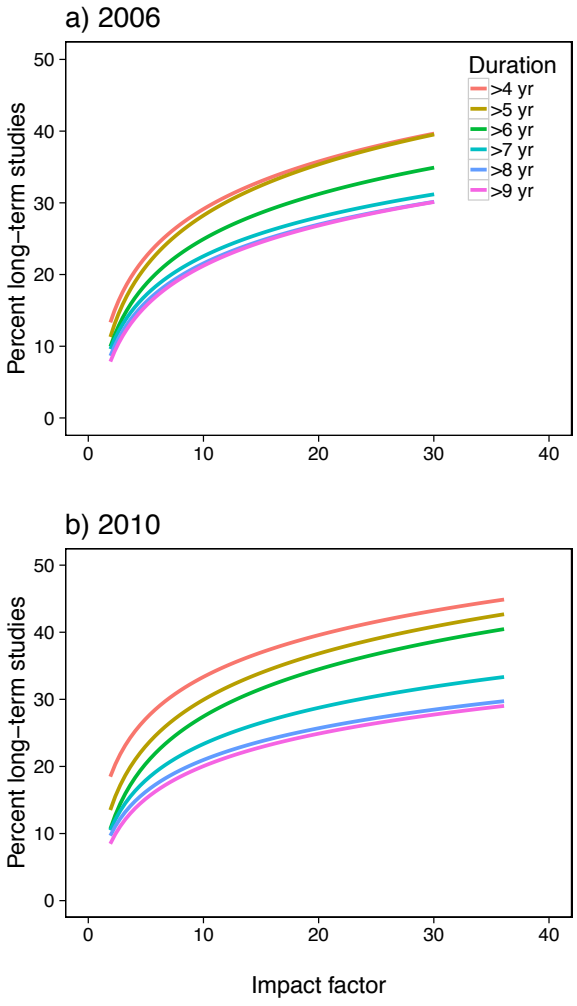

Figure s3. Evaluation of categorizing LTEES by > 4 to > 9 years on strength (slope) of the relationship between percent LTEES and journal impact factor. Impact factors ranged from 1 to 30 and 1 to 36 in 2006 and 2010, respectively.

Percent long-term studies and journal impact factor

We tested for relationships between the percent of studies published in a journal that were of durations greater than four years and the impact factor of that journal for each of 2006 and 2010. Journal impact factor was log10 transformed to linearize the relationships in the analysis. An ANCOVA was used to test for differences in intercept and slope of the relationships between years. There was no significant difference in slopes of the two years (ANCOVA full model interaction term: $F = 0.0617$; $df = 1$; $P = 0.806$) (figure 3). There was no significant difference in intercept (ANCOVA reduced model without interaction term: $P = 0.0525$. However, the relationship between percent long-term studies and (log) journal impact factor was significant (journal impact factor effect: $F = 25.18$; $R^2 = 0.483$; $df = 1,27$; $P < 0.0005$). Therefore, we averaged the percent long-term studies and log journal impact factor between years and tested for a relationship across these averages with simple linear regression.

Contribution of LTEES to citation rates of higher impact journals

To determine whether LTEES contributed to the higher citation rates of higher impact journals, we used all 1,800 articles published in the 14 journals in 2006 and 1,734 articles published in 2010 and tested for an interaction between journal impact factor and study duration on the number of citations per article with a two-factor analysis of variance. 2006 and 2010 were analyzed separately. Both journal impact factor and study duration were modeled as fixed effects. The rate of increase of the relationship between study duration and number of citations increased with impact factor of the journal.

Table s1. Results of two-factor analysis of variance to test for the interaction between study duration and journal impact factor on the number of citations of articles published in a) 2006 and b) 2010.

a) 2006

Source	***df***	***Sum of Squares***	***F***	***P***
Duration	1	1051432	800.23	< 0.0001
Impact Factor	1	30905	23.52	< 0.0001
Impact Factor*Duration	1	28416	21.627	< 0.0001

b) 2010

Source	***df***	***Sum of Squares***	***F***	***P***
Duration	1	354020	996.93	< 0.0001
Impact Factor	1	8658	24.38	< 0.0001
Impact Factor*Duration	1	1409	3.9682	0.04652

Evaluation of LTEES contribution to policy-informing literature

We restricted our analyses to National Research Council (NRC) reports published in 2010 in the Division of Earth and Life Studies, excluding the following subtopics: Chemical Sciences and Technology, Laboratory Animals, and Nuclear and Radiation Studies. As in our review of the scientific journals, ecological studies were defined as those that examined the relationship between living organisms or organisms and their environments. Similarly, NRC-cited ecological papers lacking empirical data sets were excluded (e.g., reviews, meta-analyses, and purely theoretical papers), as were paleoecological studies. Based on these criteria we reviewed 44 NRC reports (supplementary materials table s2) and all the ecologically-relevant citations. NRC reports cited a much greater range of years than the scientific literature of our first analyses (1951-2010 versus 2006 and 2010) and ecosystems than the ecological literature.

Table s2. Committee members of 44 NRC reports were surveyed. All reports were conducted under the Division of Earth and Life Sciences of the NRC and published in 2010.

NRC Report Title
A Review of the Proposed Revisions to the Federal Principles and Guidelines Water Resources Planning Document
A Scientific Assessment of Alternatives for Reducing Water Management Effects on Threatened and Endangered Fishes in California's Bay Delta
Adapting to the Impacts of Climate Change
Advancing the Science of Climate Change
An Evaluation of the Food Safety Requirements of the Federal Purchase Ground Beef Program
Assessment of Intraseasonal to Interannual Climate Prediction and Predictability
Assessment of Sea-Turtle Status and Trends: Integrating Demography and Abundance
BioWatch and Public Health Surveillance: Evaluating Systems for the Early Detection of Biological Threats: Abbreviated Version
Building Community Disaster Resilience through Private-Public Collaboration
Challenges and Opportunities for Education About Dual Use Issues in the Life Sciences
Climate Stabilization Targets: Emissions, Concentrations, and Impacts Over Decades to Millennia
Continuing Assistance to the National Institutes of Health on Preparation of Additional Risk Assessments for the Boston University NEIDL, Phase 2
Ecosystem Concepts for Sustainable Bivalve Mariculture
Eighteenth Interim Report of the Committee on Acute Exposure Guideline Levels
Evaluation of a Site-Specific Risk Assessment for the Department of Homeland Security's Planned National Bio- and Agro-Defense Facility in Manhattan, Kansas
Evaluation of the Health and Safety Risks of the New USAMRIID High Containment Facilities

at Fort Detrick, Maryland
Final Report of The National Academies Human Embryonic Stem Cell Research Advisory Committee and 2010 Amendments to the National Academies Guidelines for Human Embryonic Stem Cell Research
Impact of Genetically Engineered Crops on Farm Sustainability in the United States
Improving Water Quality in the Mississippi River Basin and Northern Gulf of Mexico: Strategies and Priorities
Informing an Effective Response to Climate Change
Letter Report Assessing the USGS National Water Quality Assessment Program's Science Framework
Limiting the Magnitude of Climate Change
Management and Effects of Coalbed Methane Produced Water in the United States
Missouri River Planning: Recognizing and Incorporating Sediment Management
Monitoring Climate Change Impacts: Metrics at the Intersection of the Human and Earth Systems
Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean
Precise Geodetic Infrastructure: National Requirements for a Shared Resource
Progress Toward Restoring the Everglades: The Third Biennial Review--2010
Realizing the Energy Potential of Methane Hydrate for the United States
Review of the Department of Defense Enhanced Particulate Matter Surveillance Program Report
Review of the Department of Homeland Security's Approach to Risk Analysis
Review of the Environmental Protection Agency's Draft IRIS Assessment of Tetrachloroethylene
Review of the St. Johns River Water Supply Impact Study: Report 3
Review of the WATERS Network Science Plan
Sequence-Based Classification of Select Agents: A Brighter Line
Seventeenth Interim Report of the Committee on Acute Exposure Guideline Levels
Strategic Planning for the Florida Citrus Industry: Addressing Citrus Greening
The Use of Title 42 Authority at the U.S. Environmental Protection Agency: A Letter Report
Toward Sustainable Agricultural Systems in the 21st Century
Tsunami Warning and Preparedness: An Assessment of the U.S. Tsunami Program and the Nation's Preparedness Efforts
Understanding Climate's Influence on Human Evolution
Understanding the Changing Planet: Strategic Directions for the Geographical Sciences
Verifying Greenhouse Gas Emissions: Methods to Support International Climate Agreements
When Weather Matters: Science and Service to Meet Critical Societal Needs

Relationship between year of publication, ecosystem and study duration

To determine whether differences in the range of years and the proportionate representation of ecosystems in studies cited in the ecological literature and the NRC reports might confound comparisons, we tested for relationships between study year or ecosystem and the duration of cited studies. Ecosystem was classified by freshwater, estuarine, marine, terrestrial, or "multiple" (if the study was cross-ecosystem or could not easily fit into one of the four primary categories). We used a generalized linear mixed effects model to examine the effect of study year and ecosystem on log-transformed study duration in NRC report citations, treating NRC report as a random effect (lme4 and lmerTest packages in R) (Bates 2014, Kuznetsova 2015). Study duration differed with both year and ecosystem for the general ecological literature (supplementary materials table s3a, figure s4a). However, the general linear mixed model indicated that study duration was slightly related to year with little indication of ecosystem differences for studies cited in NRC reports (supplementary materials table s3b, figure s4b).

To address whether publication journal affected our results, we analyzed a subset of the data that included only the focal journals from the general ecological literature analysis and found similar results. The magnitude of this difference in median study durations increased from 1.30 years to 1.34 years when considering only studies published in our focal set of 15 ecological journals (t-test, $t = 4.36$, $df = 3532$, $P < 0.001$, 95 % *CI*: 1.17 - 2.30).

Table s3. (a) Tests of relationships between year (2006 and 2010) and ecosystem (fixed factors) and journal (random factor) on study duration from studies in the general ecological literature using a general linear mixed effects model. **(b)** Tests of relationships between year and ecosystem (fixed factors) and journal (random factor) on study duration of publications in the reviewed NRC reports. Results from generalized linear mixed effects model show fixed effects only. Reference group for ecosystem is "multiple".

(a) General Ecological Literature

	Parameter Estimate	***Std. Error***	***t***	***P***
Intercept	-68.75	16.71	-4.115	< 0.0001
Year	0.035	0.008	4.212	< 0.0001
Ecosystem: freshwater	-0.807	0.202	-3.989	< 0.0001
Ecosystem: marine	-0.635	0.199	-3.185	0.0015
Ecosystem: terrestrial	-0.618	0.195	-3.176	0.0015

(b) NRC Cited Literature

	Parameter Estimate	***Std. Error***	***t***	***P***
Intercept	-14.66	8.158	-1.798	0.0725
Year	0.008	0.004	1.923	0.0547
Ecosystem: freshwater	-0.258	0.194	-1.331	0.1833
Ecosystem: marine	-0.009	0.134	0.703	0.4821
Ecosystem: terrestrial	-0.162	0.163	0.992	0.3216

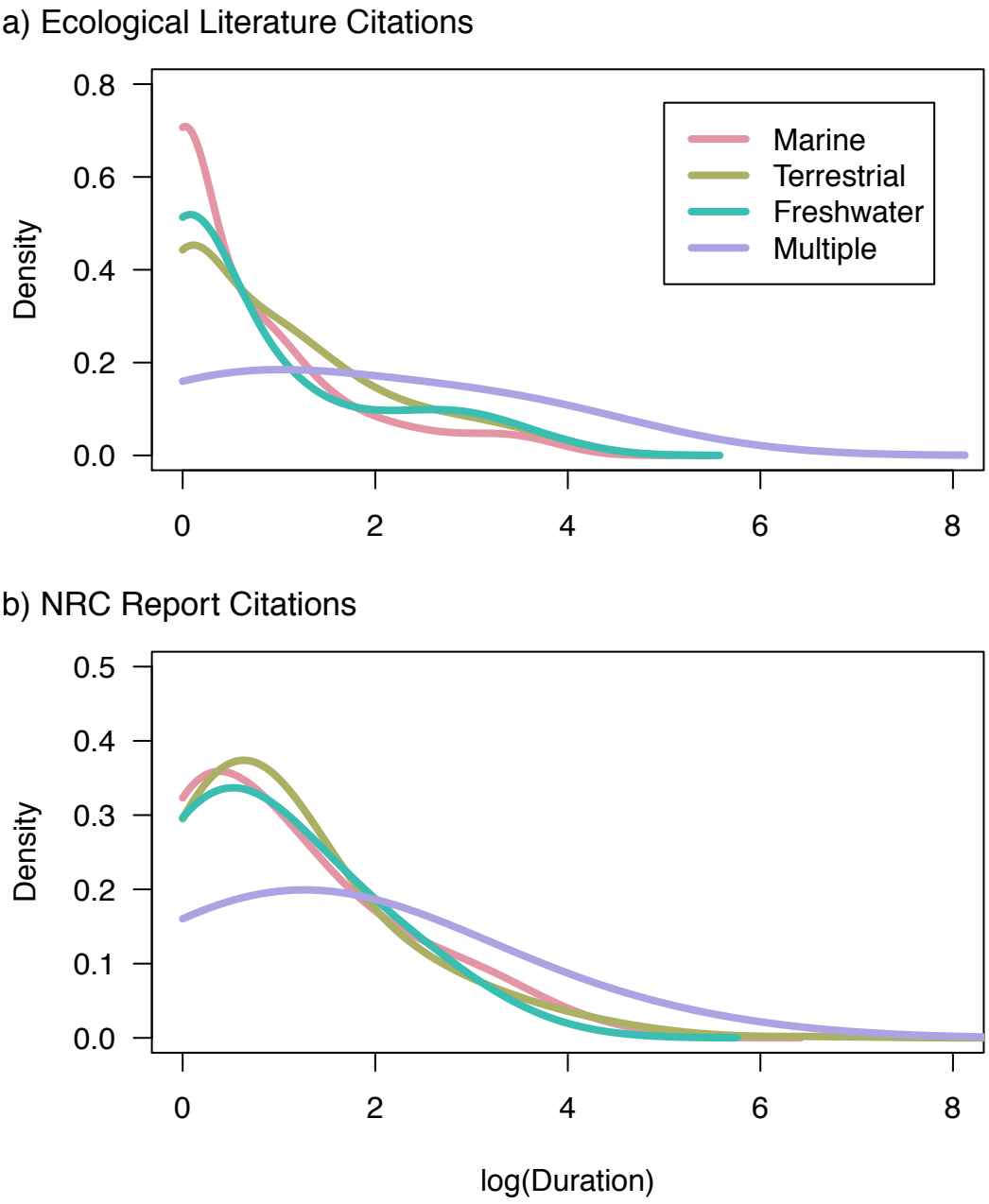

Figure s4. Density plot showing the distribution of log study durations from the (a) General Ecological Literature and (b) NRC citations by study ecosystem. Mean log-transformed durations by system for (a) are 0.632 (marine), 0.936 (terrestrial), 0.770 (freshwater), and 1.658 (multiple), and for (b) are 1.918 (marine), 2.171 (terrestrial), 1.421 (freshwater), and 1.897 (multiple).

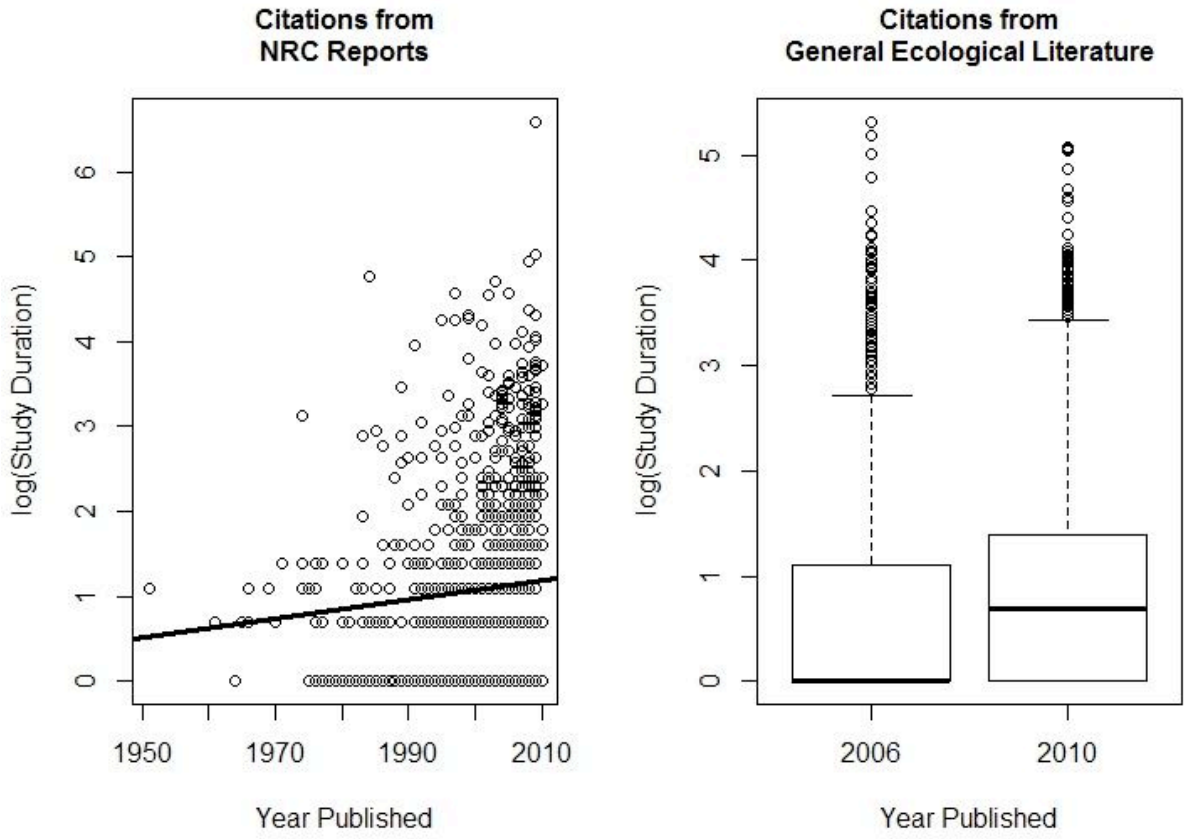

Figure s5. Relationship between year of publication and log-transformed study durations for citations from NRC reports (left) and the general ecological literature (15 journals; right). In both cases, study duration increased over time.

NRC author survey methods

The survey of NRC report authors was conducted with the approval of the Oregon State University Institutional Review Board (IRB) for inclusion of human subjects (IRB #5882).

Participants

The survey population was comprised of all authors for each of the 44 NRC reports that were analyzed in the NRC reference analysis. Names and email addresses of authors were obtained from publicly available data on the NRC website and through internet searches. The 480 resulting authors were emailed a link to the survey, which was hosted using the Qualtrics survey software (http://www.qualtrics.com/). Survey participants were given two months to complete the survey. All 114 respondents (23.75 % response rate) remained anonymous, and any identifying information was kept independent from responses.

Survey Questions

The survey first asked each report author to identify her/his sector of work (i.e., government, academia, non-governmental organization, and industry), field(s) of expertise, and the NRC report authored. Authors were then asked a series of question to determine: (1) the opinion of NRC authors on the value of long-term ecological research, and its contribution to scientific knowledge and policy decisions, (2) the importance of studies of different durations for the conclusions of the NRC report, (3) the importance of study duration in determining why a study was included, and (4) the difference in citation frequency of studies of different durations between ecologists and non-ecologists (see supplementary materials table s4). Note that while NRC report authors were asked questions regarding the "duration" of cited studies, we did not

explicitly define duration in the survey questions. The strong correlation between span and duration as defined in our NRC citation analyses indicates the feasibility of comparisons between the literature citation duration analyses and survey results (supplementary materials figure s6).

Survey Analysis

We asked two types of questions, Likert-scale and rank-style, each requiring a different statistical analysis. Likert-scale questions asked respondents to choose the degree to which they agreed with a statement, or the degree to which they thought the statement was important. Respondents could choose one of five options: Strongly Agree (Very important), Agree (Important), Neither Agree nor Disagree (Neither Important or Unimportant), Disagree (Unimportant) or Strongly Disagree (Very Unimportant).

Likert-scale questions were analyzed using a non-parametric Wilcoxon signed rank test on the distribution of ranked answers where strongly agree = 1, agree = 0.5, neither agree nor disagree = 0, disagree = -0.5, and strongly disagree = -1. Our null hypothesis was that the mean rank was not statistically different from 0.

For rank-style questions, respondents were asked to order given statements from most to least important, or from most to least frequently cited. Rank-style questions were analyzed using non-parametric Wilcoxon signed rank test to assess whether studies of a given duration were ranked as “most important” (rank of first) more frequently than expected under the null hypothesis that the chance of any one of the statements being ranked as the most important (most frequently cited) was equal. With four options to rank, the probability of each statement being ranked as most important was thus 1 to 4. We then used the Wilcoxon non-parametric comparison test to determine significant differences between pairs of study duration. Finally, we compared

differences in responses for each study duration category using a two-sample Wilcoxon rank sum test. Statistical analyses were performed using JMP (v. 12; SAS, U.K.).

Table s4. Comprehensive list of questions asked to survey participants, and the responses they had to choose from.

Question	**Response Options**
1. In total, on how many NRC report committees have you sat as a member or chair?	1, 2-3, 4+
2. Which of the following most closely describes your profession at the time you were an NRC report committee member or chair?	Agency scientist / resource management scientist; Environmental professional; Industry professional; Professor / academic researcher; Public policy or government official; Other (please specify) _____
3. Which of the following describes your field(s) of expertise? (check all that apply)	Agriculture Food and Renewable Resources; Anthropology; Atmospheric and Hydrospheric Sciences; Biology; Chemistry; Education; Engineering; Geology and Geography; Mathematics; Medical Sciences; Natural Resources; Physics; Psychology; Social, Economic, and Political Sciences; Statistics
3.5. [Note: this question only appears if "Biology" is selected in Question 3.] Within the field of biology, which of the following describes your field(s) of expertise? (check all that apply)	Ecology; Evolution; Molecular Biology; Physiology
4. What was the most recent NRC report for which you served as committee member or chair? Please select the year and then the report title.	Year: 2009, 2010
5. Did the NRC committee on which you served include anyone with expertise in ecology?	Yes; No
6. Did you cite ecology-related references in your NRC report?	Yes; No; I don't know

[Note: If "No" or "I don't know" is selected, then the respondent is taken to Question 13.]	
7. How important was each factor for citing an ecology reference in your NRC report? Factors: Study authors Journal prestige/ impact factor Temporal extent of study Spatial extent of study Publication date Location of study Study conclusions	Very Unimportant; Somewhat Unimportant; Neither Important nor Unimportant; Somewhat Important; Very Important; Unable to Rate
8. For the same factors, how important was each factor for citing an ecology reference in your NRC report? Drag and drop the options in the order of their importance. (top = most important, bottom = least important)	Factors: Study authors; Journal prestige/ impact factor; Temporal extent of study; Spatial extent of study; Publication date; Location of study; Study conclusions
9. Of the ecology references, how important were studies of the following durations to the conclusions or recommendations of your report? Drag and drop the options in the order of their importance. (top = most important, bottom = least important)	Citation Frequency: 1 year or less; 2-5 years; 6-10 years; 10+ years
10. Of the ecology references, how often did you cite studies that included each of the following study types? Study Types: Theoretical, modeling Empirical, with primary data Review Meta-analysis	Never; Infrequently; Frequently; Always; Unable to Rate
11a. Of the ecology references, how often did you cite studies of the following durations?	Citation Frequency: 1 year or less; 2-5 years; 6-10 years; 10+

Drag and drop the options in the order of their frequency. (top = most frequent, bottom = least frequent)	years
11b. [Note: this question only appears if 6-10 years and 10+ years are ranked 3rd frequent in Question 11.] How would you best explain why you cited 6-10 and 10+ year studies least often?	We found that studies of 6+ years were less relevant to the topic of the NRC report. We found that studies of 6+ years were not as common in the literature as shorter-term studies. We were less familiar with studies that have a duration of 6+ years. We did not consider study duration in reference selection. Other (please specify) : _____
12. To what level do you agree or disagree with the following statements? Statements: Our NRC committee was more inclined to cite a study if it used a long-term data set (6+ years). Our NRC committee was more inclined to cite a study if it used a short-term data set.	Strongly Disagree; Disagree; Neither Agree nor Disagree; Agree; Strongly Agree
13. To what level do you agree or disagree with the following statement? Long-term ecological data sets provide information that short-term studies cannot provide.	Strongly Disagree; Disagree; Neither Agree nor Disagree; Agree; Strongly Agree
14. To what level do you agree or disagree with the following statement? Long-term ecological data are important for informing policy.	Strongly Disagree; Disagree; Neither Agree nor Disagree; Agree; Strongly Agree
15. Please enter any other comments you'd	

like to share with us about ecology-related references in NRC reports.	

NRC author survey results

Table s5. Reasons why survey respondents did not rank studies of longer durations (10+ years or 6-10 years) as frequently cited (question 11b). The total number of respondents is 18. Survey respondents were only directed to question 11b if they ranked studies of 6-10 years and 10+ years as the least frequently cited (3rd or 4th place ranking).

Reason given for infrequent citation	***Number of respondents***	***Percentage of respondents***
We found that studies of 6+ years were less relevant to the topic of the NRC report.	2	11.1%
We found that studies of 6+ years were not as common in the literature as shorter-term studies.	10	55.6%
We were less familiar with studies that have a duration of 6+ years.	0	0.0%
We did not consider study duration in reference selection.	5	27.8%
Other	1	5.5%

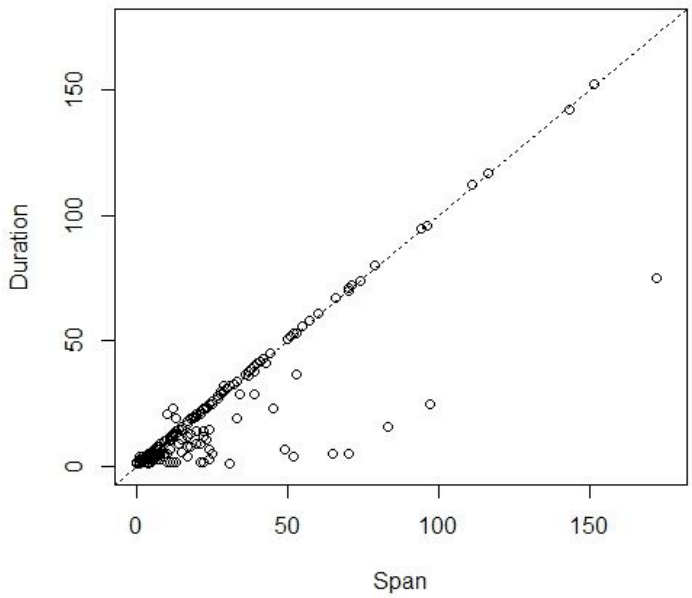

Figure s6. Relationship between span (study end year - study start year) and duration (number of years of "effort"; see methods) of all ecological studies cited in the reviewed NRC reports. Dotted line is the 1:1 ratio of span to duration. Pearson's correlation coefficient for this relationship, r = 0.9174.

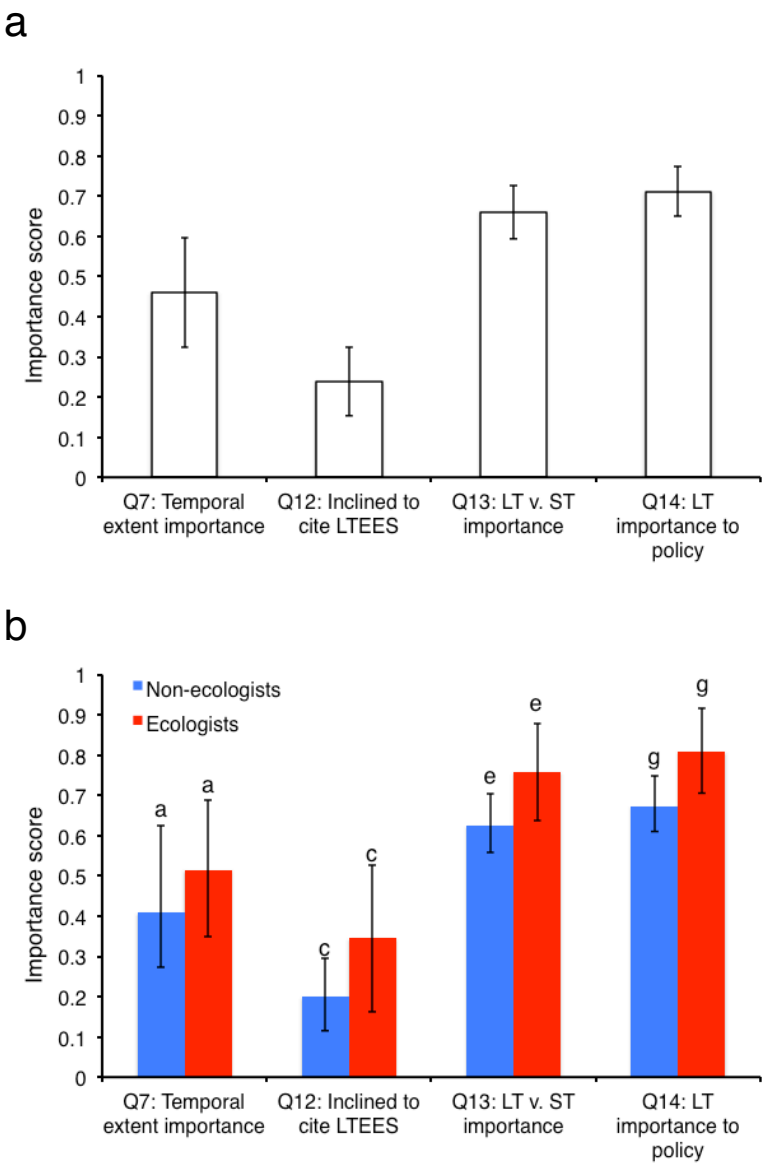

Figure s7. Results from survey of authors of NRC reports asking the overall importance from several survey questions (supplementary materials table s5) for both a) pooled respondents and b) testing for the difference in responses between non-ecologists v. ecologists. Importance scores range from -1 to 1 with positive values reflecting greater agreement for the importance of LTEES. Likert-scale questions were analyzed using a non-parametric Wilcoxon signed rank test on the distribution of ranked answers. The mean was compared to the null hypothesis (null = 0) for a) and b). Differences in lettering for b) indicate significant differences ($P < 0.05$) from paired comparisons between non-ecologists and ecologists for each question, using a Wilcoxon/Kriskal-Wallis test, P-values for questions 7, 12, 13, 14 were 0.81, 0.06, 0.08, and 0.06, respectively. Error bars are 95% CI.

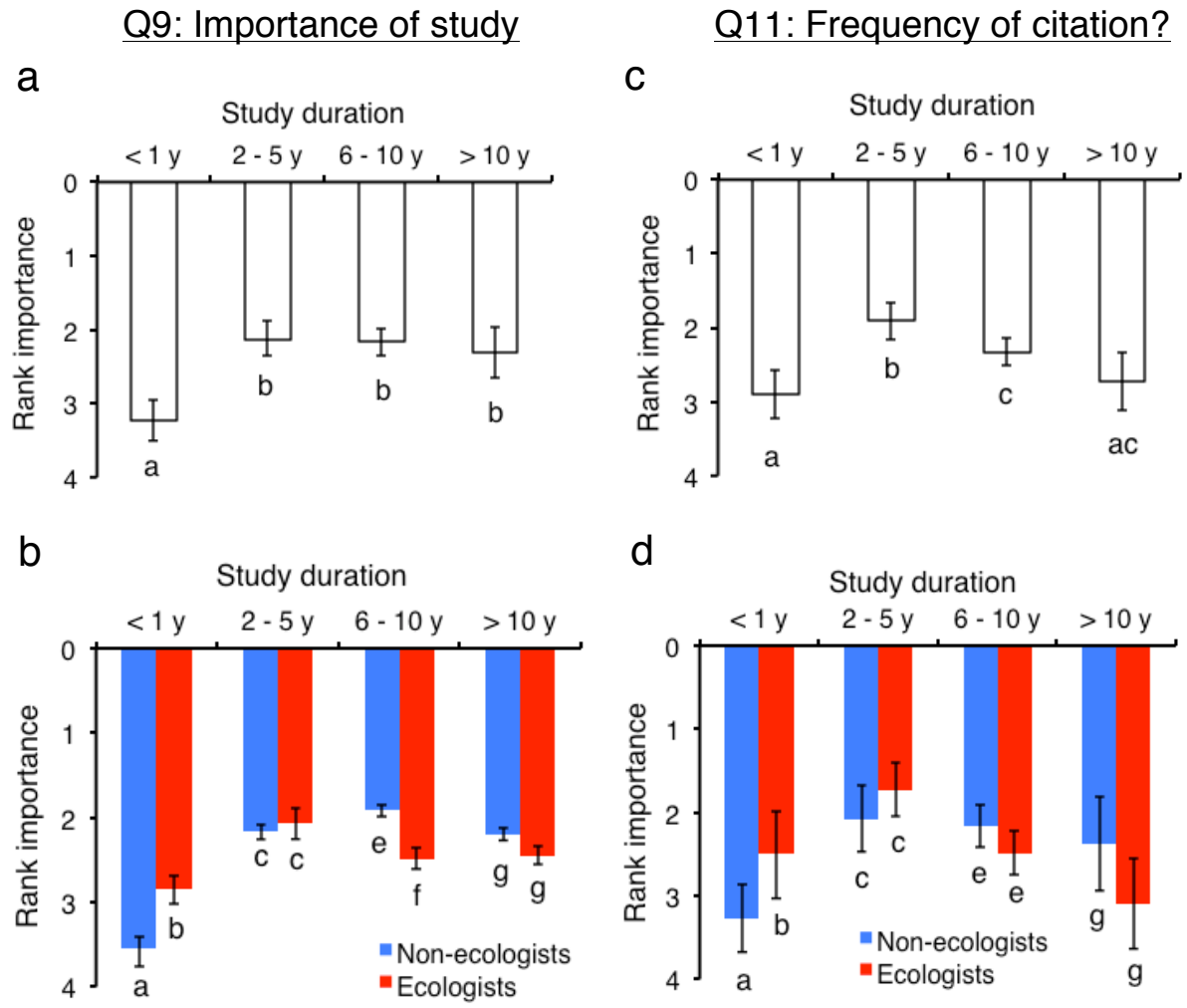

Figure s8. Results from survey of authors of NRC reports asking the rank importance (1 = very important to 4 = not important) for survey questions 9 and 11 (supplementary materials table s3) for both a) and c) pooled respondents, and b) and d) testing for the difference in responses between non-ecologists v. ecologists. Responses (ranks) were analyzed using a Wilcoxon/Kriskal-Wallis test. Differences in lettering indicate significant differences from paired comparisons ($P < 0.05$). For b) and d), differences in lettering compared the difference in response between non-ecologists and ecologists for each study duration category. Error bars are 95% CI.

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