



Detecting Human Impacts in Marine Habitats

Craig W. Osenberg, Russell J. Schmitt

Ecological Applications, Volume 4, Issue 1 (Feb., 1994), 1-2.

Your use of the JSTOR database indicates your acceptance of JSTOR's Terms and Conditions of Use. A copy of JSTOR's Terms and Conditions of Use is available at <http://www.jstor.org/about/terms.html>, by contacting JSTOR at jstor-info@umich.edu, or by calling JSTOR at (888)388-3574, (734)998-9101 or (FAX) (734)998-9113. No part of a JSTOR transmission may be copied, downloaded, stored, further transmitted, transferred, distributed, altered, or otherwise used, in any form or by any means, except: (1) one stored electronic and one paper copy of any article solely for your personal, non-commercial use, or (2) with prior written permission of JSTOR and the publisher of the article or other text.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

Ecological Applications is published by The Ecological Society of America. Please contact the publisher for further permissions regarding the use of this work. Publisher contact information may be obtained at <http://www.jstor.org/journals/esa.html>.

Ecological Applications

©1994 The Ecological Society of America

JSTOR and the JSTOR logo are trademarks of JSTOR, and are Registered in the U.S. Patent and Trademark Office. For more information on JSTOR contact jstor-info@umich.edu.

©1999 JSTOR

Detecting Environmental Impacts

Detecting Human Impacts in Marine Habitats

Despite substantial effort expended on environmental impact studies and monitoring programs, considerable uncertainty remains about the nature and magnitude of ecological impacts associated with anthropogenic activities in coastal marine environments (e.g., NRC 1990, 1992). A major constraint on the reliable detection and estimation of ecological impacts is the inherent difficulty of isolating effects from natural spatial and temporal variability (NRC 1990). Indeed, there remains healthy debate about the relative merits of different field-assessment designs (e.g., Hurlbert 1984, Stewart-Oaten et al. 1986, 1992, Carpenter et al. 1989, Schroeter et al. 1993, Stewart-Oaten 1993, Underwood, this volume). The following three papers provide complementary perspectives on sampling and design issues related to the detection of ecological impacts in marine habitats.

In the first paper, Underwood lays out his views of salient issues underlying field assessment designs. Unlike the Before-After-Control-Impact (BACI) approach popularized by Stewart-Oaten et al. (1986), Underwood's "beyond-BACI" design requires multiple control sites, and evaluates these data with an asymmetrical analysis of variance model. The design potentially can detect a greater variety of impacts than other BACI designs (e.g., effects on variance as well as the mean).

In the next paper, Osenberg et al. evaluate how natural spatial and temporal variability, coupled with estimated magnitudes of environmental impacts, constrain the detection of impacts on different environmental parameters. They conclude that effects on individuals may be more easily detected than effects on populations (although the latter are often of more interest to policymakers), and call for greater integration of individual-based studies into field assessments.

In the final paper, Thrush et al. explicitly examine the relative magnitudes of spatial and temporal variation in benthic population densities to determine how spatial variation can confound temporal patterns. They show how the

detection of temporal trends (including key events in a population's dynamics) depends on the ratio of spatial to temporal variability. They conclude that direct analysis of the magnitude of spatial and temporal variation will lead to more appropriately designed sampling programs and thus assessment studies.

Finally, we note that well-designed field assessments complement the emerging process of ecological risk assessment (the prediction of environmental impacts, largely from laboratory data and toxicological and population models; Suter 1993). Neither substitutes for the other. Rather, the quality and applicability of ecological risk assessment can only be judged by the degree to which its predictions match observed impacts. This requires estimation (not just detection) of the impact, which necessitates that the effect be measured amidst background variation with minimal error and bias. This is not a trivial task (neither in theory nor in practice), and we hope that the following papers generate useful discussion and thus improve field assessments of impacts caused by human activities.

LITERATURE CITED

- Carpenter, S. R., T. M. Frost, D. Heisey, and T. K. Kratz. 1989. Randomized intervention analysis and the interpretation of whole-ecosystem experiments. *Ecology* **70**:1142-1152.
- Hurlbert, S. J. 1984. Pseudoreplication and the design of ecological field experiments. *Ecological Monographs* **54**:187-211.
- NRC [National Research Council]. 1990. *Managing troubled waters: the role of marine environmental monitoring*. National Academy Press, Washington, D.C., USA.
- NRC [National Research Council]. 1992. *Assessment of the U.S. outer continental shelf environmental studies program. II. Ecology*. National Academy Press, Washington, D.C., USA.
- Schroeter, S. C., J. D. Dixon, J. Kastendiek, R. O. Smith, and J. R. Bence. 1993. Detecting the ecological effects of environmental impacts: a case study of kelp forest invertebrates. *Ecological Applications* **3**:331-350.
- Stewart-Oaten, A. 1993. Evidence and statistical

summaries in environmental assessment. *Trends in Ecology and Evolution* **8**:156-158.

Stewart-Oaten, A., J. R. Bence, and C. W. Osenberg. 1992. Assessing effects of unreplicated perturbations: no simple solutions. *Ecology* **73**:1396-1404.

Stewart-Oaten, A., W. W. Murdoch, and K. R. Parker.

1986. Environmental impact assessment: "pseudoreplication" in time? *Ecology* **67**:929-940.

Suter, G. W., editor. 1993. *Ecological risk assessment*. Lewis, Ann Arbor, Michigan, USA.

CRAIG W. OSENBURG,
University of California at Berkeley

AND

RUSSELL J. SCHMITT,
University of California at Santa Barbara

Key words: BACI design; coastal marine environments; ecological impacts; impact assessment; spatial and temporal variability; statistical power.