Detecting Human Impacts in Marine Habitats

Craig W. Osenberg, Russell J. Schmitt

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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 policy-makers), 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.

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CRAIG W. OSENBERG,
University of California at Berkeley
AND
RUSSELL J. SCHMITT,
University of California at Santa Barbara

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