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2 **The Exxon Valdez Oil Spill Revisited and the Dangers of Normative Science**

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11 **Abstract.** In the July 2006 issue of *Integrated Environmental Assessment and Management*, a
12 paper by Harwell and Gentile was published assessing the present ecological significance of the
13 impacts from the Exxon Valdez oil spill (EVOS). First, this paper compares the major
14 conclusions of Harwell and Gentile and a paper reviewing the current impacts of EVOS by
15 Peterson et al. as published by *Science* in 2003. Stark differences exist between the conclusions
16 of the 2 papers regarding continuing impacts. Part of the difference appears to be the infusion of
17 different social values or policy goals into each. Normative science is the use or interpretation of
18 data in support of specific values or policies. Examples of values or policies intertwined with
19 science are constructs such as ecosystem health, ecosystem integrity, ecological significance and
20 recovery. Examination of the environmental risk assessment and toxicology literature reveals
21 that the symptoms of normative science are common and the implications widespread.
22 Separation of science from policy or at a minimum a transparent acknowledgement of the
23 science-policy interaction is clearly necessary in order to obtain a clear picture of the ecological
24 system under investigation.

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26 **Keywords:** Exxon Valdez oil spill, normative science, ecological significance, recovery,
27 environmental policy

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2 INTRODUCTION

3 The mission of a journal is to present publications that have undergone the peer-review
4 process. In the case of *Integrated Environmental Assessment and Management (IEAM)* the
5 mission has been to integrate research and management in an open forum that encourages
6 discussion and the derivation of new approaches. Different from its older sister publication,
7 *Environmental Toxicology and Chemistry*, *IEAM* is charged with the publication of debates,
8 commentaries, editorials, and policy analysis in order to fulfill the mission of *IEAM*.

9 ANALYSIS OF TWO PAPERS

10 The recent publication by Harwell and Gentile (2006) revisits the persistence of impacts
11 of the 1989 Exxon Valdez oil spill (EVOS). The impacts of the spill and their persistence are
12 controversial. This is not just a scientific debate as the controversy also exists in the public
13 domain as demonstrated by a recent article in *Time Magazine* (Caplan 2006). My short
14 commentary compares Harwell and Gentile (2006) to the widely cited *Science* article of Peterson
15 et al. (2003) and other developments. The context of the comparison is the insertion of
16 normative terminology and frameworks into environmental toxicology, risk assessment and
17 environmental management as illuminated by Lackey (2004)

18 Peterson et al. (2003) clearly state that persistent oil and chronic exposures continue to
19 cause impacts to wildlife. The assessment model that they use is a derivation of a before-after
20 control-impact (BACI) as described by Parker and Wiens (2005). Peterson et al. also state that
21 indirect effects and the resulting cascades within the marine community have prevented recovery
22 of the system. Table 1 of the article (page 2085) summarizes the comparison between the old
23 and new paradigms for oil toxicology for marine ecological systems. The new paradigm is

1 comprised of an assumption of increased persistence of the oil, a role for chronic effects upon
2 organisms and cascades of indirect effects for populations and communities. The lack of
3 inclusion of indirect effects was stated as one of the weaknesses of ecological risk assessment in
4 the estimation of resource loss.

5 In contrast Harwell and Gentile (2006) dismiss the importance of indirect effects and
6 cascades due to the EVOS event. They state:

7 “We believe that the primary drivers for cascading effects in the PWS ecosystem relate to
8 fundamental processes driven by climatic and oceanographic variability, especially
9 involving nutrient upwelling and fish productivity..” (page 231)

10 The contrast is made more explicit by Harwell and Gentile later in the paper:

11 “Some would argue that so-far-unrealized indirect or cascading effects from EVOS could
12 in the future plague PWS (such as suggested by Peterson et al. 2003). We quite disagree:
13 the very real cascading effects on the PWS ecosystem over the past several decades from
14 fundamental natural stressors, especially climate and oceanographic variability, and the
15 pervasive anthropogenic stressor of overexploitation of marine resources are significant
16 and would overwhelm any proposed EVOS signal.” (page 238)

17 Peterson et al. (2003) identify instances of population level effects as additional support
18 for the oil toxicity hypothesis. Harwell and Gentile do not cite a source for the contention in the
19 above quote that cascading effects are only due to larger scale stressors. Conversely, Peterson et
20 al. do not eliminate regional scale stressors as a causal factor for some of the observed effects.
21 Clearly there is an important difference in how the two studies regard indirect effects and
22 cascades.

1 There are many other similar contrasts between Peterson et al. (2003) and Harwell and
2 Gentile. However, many of the differences in the interpretation of the available information may
3 be tied to a more fundamental issue. The defining of “effect” in each paper is quite different and
4 is a more important contrast. Understanding this contrast is critical to the fields of environmental
5 toxicology, risk assessment, and management.

6 Harwell and Gentile state that an effect with “ecological significance” includes 2 factors:
7 1) Whether a change in a valued ecosystem component (VEC) is of sufficient type, intensity,
8 extent, and/or duration to be important to the structure, function, and/or health of the system, and
9 2) whether a change in a VEC is sufficient to exceed natural variability or alters the innate
10 variability of the system. The 1st criterion incorporates words such as “important” and health,
11 terms that are inherently value driven. The 2nd criteria discusses natural variability, but over
12 what time frame? Neither criterion discusses spatial or temporal scales, begging the point about
13 if we are talking impacts over all of Prince William Sound and variability over time frames of 1,
14 10, 100 y, or since the last glaciation. Both criteria have underlying and innate value systems
15 that are being applied by the authors.

16 Recovery is the analogous term used in Peterson et al. (2003). Recovery is not defined
17 within the paper but the use of the term appears to be synonymous with return to conditions prior
18 to the EVOS or that no statistically significant difference exists between oiled and not-oiled sites.
19 This is the before–after control–impact (BACI) model as defined by Parker and Wiens (2005).
20 Recovery assumes an equilibrium state, but that is now recognized as a poor model for
21 describing the dynamics of ecological structures or environmental impacts (Wu and Loucks
22 1995; Kapustka and Landis 1998). How alike is alike? Are there criteria for specifying the
23 statistical power of a field study to define the level of population or reproductive performance

1 compared to pre-event levels? Determining sufficient statistical power or how close
2 measurements have to be to be similar enough becomes a trade-off between resources and value
3 judgments on how close is close enough.

4 Note that in the definitions of “ecological significance” and “recovery” there are societal
5 values incorporated into each. In the Harwell and Gentile (2006) definition of ecological
6 significance it is straightforward to identify the value-laden terminology (important, ecosystem
7 health). The term “recovery” has value driven assumptions that are implied in the assumptions
8 about equilibrium. It is not realistic to expect any person or group to completely disassociate
9 themselves from the cultural value systems imposed by religion, political affiliation, ethnic
10 background or an employer’s value system and mission. However, the onus is upon the authors
11 in reporting results to lay that context aside. As the fundamental definitions of each paper are
12 driven by different sets of value systems, both papers have at least some of the definitive
13 characteristics of normative science.

14 **NORMATIVE SCIENCE**

15 How can such divergent conclusions about the effects of the EVOS be reached by
16 reviews using information from the same site? R. Lackey in a series of papers (Lackey 2001,
17 2004, 2006) has investigated the interaction between values, policy and the use of science in
18 environmental management. He coined the phrase normative science (Lackey 2001). Normative
19 science is described as science that is developed, presented or analyzed based upon an assumed
20 policy or outcome. One of the best examples presented by Lackey of policy woven into science
21 is the term ecosystem health and the related term integrity. His analysis clearly demonstrates
22 that an underlying policy or value statement of ecosystem health is that it is a specified system
23 even as modified by human activity. Ecosystem health is a policy statement, not a scientific one.

1 The term “ecosystem integrity” also has policy implications. Ecosystem integrity is defined as a
2 system as it would exist without human interference and are often labeled as pristine, reference
3 or baseline conditions (Lackey 2001). The assumption underlying integrity is that there is a
4 specified state for an ecological system given its location, bioregion, etc. Ecosystem health and
5 integrity are Clementian ecology based upon assumptions of stability and specificity that have
6 been found inadequate in describing the properties of ecological structures (Wu and Loucks
7 1995; Kapustka and Landis 1998; Wu and David 2002). Since ecosystem health is a policy
8 statement and ecosystem integrity is an outmoded idea, a definition of ecological significance or
9 recovery that invokes these constructs are policy statements.

10 The use of value laden terms such as ecological significance or ecologically significant are
11 widely used in the literature. In a search of *Environmental Toxicology and Chemistry* and *IEAM*
12 from June of 2001 to June 2006, 75 papers were found to use those terms at least once. The
13 same search parameters for the journal *Environmental Science and Technology* resulted in 50
14 papers being identified. Clearly the terminology is widespread in the scientific literature. A
15 review of the citations reveals that the vast majority of the citations are not policy statements but
16 purport to be scientific investigations.

17 In environmental science separating what is science from what is a policy is difficult.
18 Ecological significance as defined by Harwell and Gentile (2006) is based upon a policy
19 statement, as long as the range of the impact is within the range of natural variation that the
20 impact is acceptable. Recovery is the analogous term in Peterson et al. (2003). Recovery is not
21 defined within the paper but the use of the term appears to be synonymous with return to
22 conditions prior to the EVOS or that no statistically significant difference exists between oiled

1 and not-oiled sites. There are a number of definitions for recovery (reviewed in Parker and
2 Wiens 2005); the decision of which to use is a policy decision.

3 Has our research as a community of scientists been corrupted by the advocacy of specific
4 values by the use of terms such as ecological significance or recovery? Lackey (2006) in his
5 “ecological policy axiom 5” states that many advocates cloak their arguments as science to hide
6 policy preferences. Has the use of terminology without a scientific root led practitioners to
7 advocate consciously or unknowingly for a particular policy outcome? Has the legacy of Silent
8 Spring (Carson 1962), an excellent example of persuasive writing and policy promotion, led to a
9 scientific culture trying to emulate that style?

10 So what are the alternatives, vaccination? I concur with Lackey (2001) that there are
11 two. The 1st is to cease the use of normative science and to relegate terms such as ecological
12 significance, integrity and recovery (in its Clementian context) to the dustbin. Describe clearly
13 what is the purpose and findings of the study. Communicate the state of the ecological system
14 and the ongoing dynamics. Statements such as “We believe” (see Hartwell and Gentile 2006) are
15 the province of items or paradigms taken on faith rather than science. The 2nd alternative is to
16 understand that ecological policy is a complex and multi-component decision making process
17 that can not be summarized in metaphorical clichés such as ecosystem health, ecological
18 significance, integrity or recovery. If a policy goal is being discussed or supported it should be
19 clearly defined and obvious to the reader.

20 One of my favorite men of science is T. H. Huxley, one of the instigators of connecting
21 science to environmental management. In his time religion, societal values, and science were
22 particularly difficult to distinguish. One of my favorite quotes attributable to him is “God give

1 me strength to face a fact though it slay me”, or as I would add, regardless of the policy of my
2 employer, family, colleagues or funding source.

3 In a journal such as *IEAM*, with a mixture of science, policy and commentary the
4 differentiation is even more important. The outcome for me of this evaluation is an appreciation
5 for just how important it is for this journal and others to ensure that the review process is
6 adequate in differentiating policy from science, and the caveat regarding normative science.
7 Would it be ironic if controversies such as that illustrated above for the impacts of the Valdez oil
8 spill are really policy debates, not a controversy of scientific merit.

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