

**When Values Conflict: An Application of Multiattribute
Decision Analysis to Marine Sand and Gravel Mining**

by

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ABSTRACT

Resources management decisions often involve conflict of human values. The suggestion to allow sand and gravel mining on the continental shelf is no exception. Miners want profit, environmentalists want to contain growth and government officials have mandates to protect the marine environment. How should government officials, custodian of public resources under the public trust doctrine and constrained by the National Environmental Policy Act, make decisions of whether and where to allow marine mining?

Several recent proposed projects and research panels provided case studies and potential decision participants. A review of the basis for marine sand and gravel extraction, the published views of potential decision participants, the potential environmental impacts and the legal framework showed that the decision structure must be capable of handling these characteristics: multiple and conflicting objectives, uncertainty and multiple actors.

An extensive review of models of decision making showed that decision analysis can handle the required characteristics. This research is an experimental test of a collection of these techniques which appear useful.

The overall research question is whether multiattribute decision analysis can be used as a practical decision aid in marine sand and gravel mining. Four hypotheses were used to test the validity of the overall research question.

Hypothesis 1 asserts that multiattribute utility functions (MUFs) can capture the essence of the conflicting values of the participants. Interviews were conducted with 17 people who are decision participants and their MUFs assessed through standard techniques. The MUFs were used to rank order three alternative mining sites and the no mining alternative. The predictions of their MUFs agreed with their publicly stated positions. A sensitivity analysis was conducted on the effects of including uncertainty using Monte Carlo simulation, yielding the same conclusions.

Hypothesis 2 tests whether a reduced n'-attributed MUF can be used in place of the original n-attributed MUF. Byer's screening technique was used to estimate the maximum amount of precision lost by eliminating some attributes. It was found that a 4-attributed MUF gave identical predictions as the original 6-attributed MUF. It was also found that certain features of the Byer screening technique can be used as a quantitative environmental impact assessment device.

Hypothesis 3 test whether the opinion/preferences of these 17 actors, as captured by the MUFs, could be classified into groups as might be expected. A series of statistical techniques were used: cluster analysis, multiple analysis of variance and canonical correlation. The results on several sets of input data showed that a priori classification by occupation and academic background into miners, government officials and environmentalists gave statistically significant groupings. Outliers were found and reclassified.

Hypothesis 4 suggested that if a Supra Decision-Maker (SDM) whose sole role is to sum preferences is postulated, then the MUF of the SDM should be used as the decision criterion. A parametric study was done to find the dominant alternative using various weights on the MUFs of various actors. The results were able to reproduce an actual decision, that the New England Offshore Mining Environmental Study was cancelled.

The overall conclusion was that the scheme of techniques tested in this research is realistic, operational and well within the monetary and human resources budgets typically used for evaluation in the federal government. Their adoption is recommended.

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