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Using normative evaluations to plan for and manage shellfish aquaculture development in Rhode Island coastal waters

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ABSTRACT

As shellfish aquaculture activities grow in the US, researchers, practitioners, resource users, and others have questioned how much development can be accommodated by natural and social systems. In a unique application of the normative evaluation approach to shellfish aquaculture development, this study uses data from a mail survey to (1) examine Rhode Islanders' support for aquaculture in general and in RI waters; (2) investigate how different features of an aquaculture farm influence normative evaluations; and (3) explore areas of agreement and disagreement among stakeholder groups for social carrying capacities associated with aquaculture in RI coastal waters. Findings demonstrate that respondents do not strictly support or oppose aquaculture development; instead support depends on the waterbody where the aquaculture is occurring, the amount of area used for aquaculture, and ways in which aquaculture is conducted. Social norm curves show that levels of acceptabilities for shellfish aquaculture development in two RI waterbodies decline with increasing levels of aquaculture activities. Comparisons among sub-sets of respondents highlight disagreement among groups on the level beyond which shellfish aquaculture development is no longer acceptable (social carrying capacity). Results from normative evaluation studies can be used in combination with physical, ecological, and biological carrying capacities; management goals and objectives; other resource uses and values; and desired social and ecological conditions to inform policy discussions about shellfish aquaculture development in coastal waters.

1. Introduction

State and Federal regulatory agencies in the US have been actively promoting sustainable aquaculture development in coastal waters to meet increasing demand for seafood, create local jobs and enhance working waterfronts [1–3]. From 2008–2013, US marine aquaculture production grew 5% per year by volume [1]. Marine shellfish aquaculture is the commercial farming of shellfish like clams, oysters, and mussels in order to harvest and sell them. Potential shellfish aquaculture impacts on the natural environment are well-documented, and include changes to food, nutrients, and oxygen in the water column as well as changes to benthic communities [4,5]. Potential impacts on nearby residents, coastal users and other relevant stakeholders have received less attention in the academic literature, although it is often social impacts that have the greatest influence on industry growth [6]. For example, studies have found that public attitudes toward aquaculture are related to perceived environmental and economic impacts [e.g., 7,8].

As shellfish aquaculture activities in the US have grown, researchers, practitioners, resource users, and others have questioned how much development can be accommodated by natural and social systems. A management concept that has received increasing attention in recent years as a way to plan and manage the growth of the aquaculture industry is carrying capacity. Carrying capacity is not a new concept, with some dating its inception back to Thomas Malthus in the 18th century [9]. Different types of carrying capacity have been discussed, including physical, ecological, biological and social. Perhaps the least well understood is social carrying capacity [10]. Social carrying capacity is the level of use beyond which environmental and social impacts exceed acceptable levels specified by evaluative standards, like satisfaction, acceptability, desirability, and preference [9,10]. Social carrying capacity has been the focus of parks, outdoor recreation, and natural resource management studies for decades [9–11]. Recent studies of aquaculture have highlighted the importance of social carrying capacity for managing aquaculture [4,6,12,13], but few, if any, studies have empirically examined social carrying capacity within the context of aquaculture. Here normative evaluation techniques from parks and outdoor recreation research are applied to the issue of

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carrying capacity in shellfish aquaculture planning and management in Rhode Island.

The amount of submerged land used for aquaculture in RI has been growing steadily over the past fifteen years [14]. Currently, 0.1% of Narragansett Bay and less than 3.0% of the coastal salt ponds along the south coast of RI are being used for aquaculture farming. Although it is increasing, this level of farming is still far below the peak aquaculture levels of the early twentieth century when about one-third of Narragansett Bay was leased for cultivating oysters [2]. In RI, some stakeholders have expressed concerns about the increasing area used for aquaculture farms, while others are promoting the industry's growth and development [15].

Stakeholders in RI are familiar with carrying capacity, at least from a biological perspective. Studies of biological carrying capacity in New Zealand informed the development of a RI regulation limiting aquaculture to no more than 5% of any salt pond, which are water bodies located along RI's southern coast [16,17]. Social carrying capacity was briefly brought up in policy discussions about the 5% rule, but no empirical data on social carrying capacity were used to develop the limit on use in the salt ponds. This is not surprising as empirical studies on social carrying capacity are limited [18].

This study explores the use of normative evaluation approaches [e.g., 19] to better understand and manage shellfish aquaculture development in RI coastal waters. First, background is presented on the concept of carrying capacity and the ways that social scientists have empirically analyzed social carrying capacity, typically in park, outdoor recreation, and resource management studies, are described. Then the application of this method to aquaculture development in RI coastal waters is described. Finally, findings and management implications are discussed.

1.1. Social carrying capacity

As noted above, social carrying capacity has been described as the level of use beyond which environmental and social impacts exceed acceptable levels of an evaluative standard [9]. Based on Jackson's [20] Return Potential Model, evaluative standards are typically measured by asking people for their preferences for different human or environmental conditions within a particular setting (e.g., number of hikers on a nature trail; number of boats in a harbor). Evaluative standards are commonly referred to as norms in the literature on human dimensions of natural resources management and recreation and leisure studies [21]. Norms clarify what individuals think the human or environmental conditions should be [18]. Social norms typically represent an average of personal norms reported by a group of individuals [18]. There is some disagreement in the literature on whether these norms, based on the structural characteristics model of norms, capture the more conventional meaning of norms which involve a sense of obligation to behave in some way and sanctions to reward or punish behavior [22–24]. However, parks and outdoor recreation researchers have argued that these norms can apply to social and environmental conditions as well as human behaviors because conditions directly result from behaviors and human behaviors involve a sense of obligation to abide by the norm and a belief that sanctions could be imposed [e.g., 19,25]. These social norms provide useful information to planners and managers about how much change is acceptable to a community, set of stakeholders, or the general public [23] and can be used to identify levels of agreement or disagreement among different groups [10].

Fig. 1 presents an example of a hypothetical social norm curve that displays average ratings of park visitors' levels of acceptability (*y*-axis) for encountering different numbers of hikers on a trail (*x*-axis) [9].

Features of the curve can be used to develop estimates of carrying capacity and inform management strategies. For example, the minimum acceptable condition is the point where the curve crosses the neutral line of the acceptability scale [18]. Beyond this point, the level of use or impact is no longer acceptable to a majority of respondents. This level

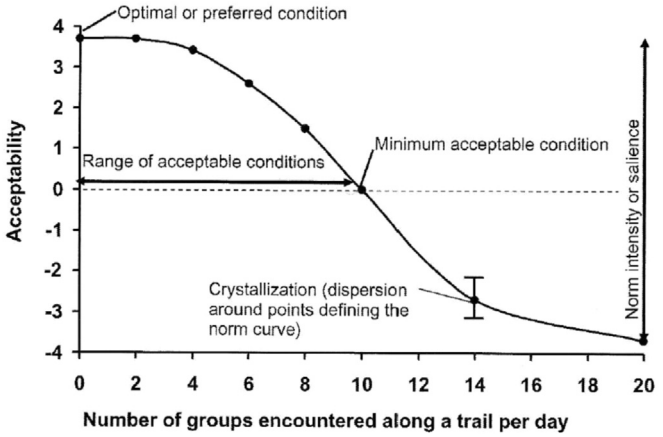

Fig. 1. Example of a hypothetical social norm curve (Source: Manning 2007).

of use or impact has been used as a basis for formulating management standards, like carrying capacity. Other features include crystallization, which captures the level of agreement among a group of respondents across different points of the curve [26], and intensity, which measures how strongly respondents feel about the use or its impacts [25]. Intensity captures the mean value of the spread between the minimum acceptable condition and the average level of acceptability (or unacceptability) across all levels of use. Crystallization and intensity are typically used to compare the relative levels of agreement and strength of feelings among different groups [20].

While most studies of normative evaluations and social carrying capacity in natural resource management have been conducted in terrestrial environments, there are some examples from the marine environment. In a study of coral reef users with varying levels of diving/snorkeling experience, Inglis et al. [27] found that crowding acceptability decreased as numbers of snorkelers increased and that different groups of respondents expressed similar norms at higher densities of people. Inglis et al. [27], like most normative research in parks, protected areas and related settings, measured norms associated with encounters with other people. A few studies in the marine environment have examined social norms for encounters with objects other than people. For instance, Needham et al. [18] found that size and number of boats within a Marine Life Conservation District in Hawai'i affected visitors' acceptability ratings for different scenes. Diedrich et al.'s [28] survey of recreational boaters anchored in Cala Xinxell (Mallorca, Spain), a popular inlet amongst boaters and beachgoers, indicated that boaters' well-being declined as boat numbers increased and that characteristics of users, such as weekend vs. weekday users, affected their preferences. This study builds on this previous work to examine the use of social carrying capacity for managing shellfish aquaculture in RI.

In this unique application of the normative evaluation approach to shellfish aquaculture, this study (1) examines Rhode Islanders' support for aquaculture in general and in RI waters; (2) investigates how different features of an aquaculture farm (waterbody, amount of aquaculture development, barge equipment) influence normative evaluations; (3) explores areas of agreement (and disagreement) among stakeholder groups for social carrying capacities associated with aquaculture in RI coastal waters; and (4) discusses how the normative approach can be used to guide aquaculture planning and management in coastal waters.

2. Methods

2.1. Study region

The study area consists of coastal waters in RI, particularly focused on Narragansett Bay and the coastal ponds along the south coast of the state. Narragansett Bay is a large estuary that supports numerous