



Analysis

The cost of useful knowledge and collective action in three fisheries

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ABSTRACT

In a complex environment knowledge is valuable and its acquisition is costly; as a result people are careful about what to learn and how to learn it. We suggest that the dynamics of the “local” environment strongly influences the method that individuals choose to acquire useful knowledge and is one of the principal determinants of the way they compete and cooperate. We focus on the way different environments lead to different costs, especially the relative opportunity costs, of search and communication and, consequently, to the emergence of different patterns of persistent cooperation and competition. In predictably regular and in predictably random environments, the cost of autonomous search is low and little social structure emerges. In complex environments, the relative costs of communication are high, leading to persistent social structure. Our presumption is that the characteristics of the emergent, or informal, social structure are a major determinant of successful collective action. We investigate the hypothesis through a comparison of three fisheries in which the costs of acquiring useful knowledge are different. Because of these differences, fishers' acquisition of useful knowledge leads to different social structure and different preconditions for successful collective action in each fishery. The lobster fishery is characterized by strong collective action and appears sustainable; the urchin and groundfisheries, worked by the same communities, are not even though almost all their participants are familiar with and often participate in the lobster fishery.

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1. Introduction

There are few fisheries in the world where collective action has led to sustainable resource management. The Maine lobster fishery is one example often cited. In the early part of the last century, the lobster fishery was thoroughly depleted (Acheson, 2003; Acheson and Gardner, 2010); in response, a long negotiation between the state of Maine, scientists and the industry led to effective and well-enforced rules restraining fishing and conserving the resource. However, the same fishing communities that have conserved lobster with such success have also pursued and thoroughly extirpated local populations of several other species, including groundfish and sea urchins. The key question is, what is it about the lobster fishery and the way it is conducted that leads to successful collective action and sustainable resource use while other fisheries worked by the same communities are overexploited?

In 1990 Elinor Ostrom published her famous list of the preconditions for successful collective action. Her list includes a number of items

that presuppose the existence of a viable civil society, i.e., collective choice arrangements, boundaries defining who is in and who is out of the institution, congruence with local ecology, monitoring, conflict resolution, and graduated sanctions. Why these social–economic attributes arise in some and not other situations is not clear. In 2000 she advocated “further work to explain why some contextual variables enhance cooperation while others discourage it” (Ostrom, 2000). In this paper we argue that the attributes Ostrom lists,² especially those that are the self-organized product of individuals' interactions with each other and with the environment, are sensitive to the costs individuals incur while acquiring knowledge that is useful to their self-interest. We assume that the social and ecological environments in which individuals reside are complex and that economic opportunities are patchy in space and variable in time. We also assume that learning about those opportunities requires either costly individual search or costly communication with other individuals. Thus, we argue that the costs of acquiring useful knowledge are one of the principal determinants of the way individuals compete and cooperate. We focus our argument on the way different environments lead to different

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² Along with those listed by others building on her work (e.g., Agrawal, 2002; North, 1990, 2007; Wade, 1994).

costs of search, communication, and learning, and consequently, to the emergence of different social structure.³ Our presumption is that the attributes of this emergent social structure are an important determinant of the likelihood of successful collective action.

This theoretical perspective is based on the evolutionary computational model of learning and adaptation in Wilson et al. (2013) and is explained in the next section of the paper. We then turn to a description of the way the problem of learning and adaptation affects the emergence of informal social structure and the likelihood of collective action in the three fisheries. We believe that this focus on the problem of learning and adaptation leads to a better understanding of the ways natural and human systems interact and, thereby, adds to the literature concerning the success and failure of collective action.

2. Learning and Adaptation

In a complex world, the acquisition of useful, usually mundane, practical knowledge is a necessary and continuing part of life. By useful knowledge, we mean knowledge about the order and regularity in complex social and natural environments (Valiant, 2013). The usefulness of this knowledge lies in the guidance it offers about the likely outcome of the alternative actions an individual might take. Presumably, the choices that individuals make about what actions to take are strongly biased towards actions that they believe will lead to beneficial outcomes.

Practical knowledge is usually acquired through personal experience and communication; its acquisition is costly. There are the direct costs of time and resources expended, but there are also important opportunity costs, especially the loss of the knowledge that might have been gained if another action had been taken. Over time, the accumulation of things learned and things not learned strongly affects the knowledge an individual chooses to acquire, focusing her knowledge about both the natural and social environment. This focusing narrows her view of the world and strongly affects her subsequent decisions about where and how she might effectively compete and cooperate. A simple, repeated path-dependent decision process drives this focus. At any moment, an individual must decide whether her interests are best served through the continued reliance on already existing knowledge or through actions that might generate new useful knowledge, i.e., through autonomous exploration or communication with others. That decision is strongly influenced by the individual's assessment of the net benefits of alternative actions which is strongly dependent on the individual's experience – that is, her focused, usually tentative, and always somewhat aged knowledge of a complex, dynamic environment.

For example, in a local part of a complex environment, a search conducted by someone who is already knowledgeable about that particular part of the environment is likely to be more directed and more likely to produce more accurate information than a search conducted by a person unfamiliar with that place. Thus, local experience can be the source of relative advantage in a competitive dynamic environment and is likely to make an individual even more strongly disposed to search familiar places again. The cost of this familiarity, however, is the loss of the knowledge that might have been acquired if other places had been searched. Similarly, repeated communications among familiar individuals are likely to be more nearly complete and less ambiguous than communications among individuals who do not know one another or the local context, leading to more informed decisions. Consequently, communications are likely to be strongly biased toward familiar individuals (Crona and Bodin, 2006). However, in a way that is similar to the results from autonomous search, the repetitive acquisition of knowledge from familiar individuals also comes at the cost of not acquiring other knowledge that might have been available from communications with and better understanding of other people.

Thus, the path-dependent effects of an individual's decisions tend to focus her knowledge towards areas and people with whom

she is already familiar.⁴ Within those areas and among those people, the individual can develop reasonably informed expectations about the likely outcome of her actions. These expectations are valuable and encourage the restrained behavior needed to maintain relationships with the individuals who are their source. Outside that particular environment her lack of experience creates pervasive uncertainty, making it more difficult for her to anticipate the outcome of her actions and, consequently, less likely to take them.

The benefits of familiarity are not unlimited, however. Familiarity feeds on itself and in the process erases some of its own benefits. That is, the more individuals know one another, the more they share a similar mental model of their environment and the less new, valuable information they can acquire from one another. In a dynamic environment, this kind of closeness creates high opportunity costs, shutting off opportunities and generating incentives for the acquisition of different knowledge from other, less familiar individuals and places. Thus, an individual has to find a balance between the benefits of communication with familiar people, which tends to diminish as her knowledge becomes too much like that of the people she works with, and the benefits of acquiring different knowledge through autonomous search and communications with unfamiliar people. The result of all individuals pursuing a similar strategy is a heterogeneous population in which each individual holds much of her knowledge in common with others, but at the same time actively differentiates herself from those others. The extent of commonality and differentiation depends largely on the costs of acquiring useful knowledge.

For an individual, the magnitude of the cost of new knowledge depends largely on his experience – i.e., what he already knows – and the complexity of his environment. For example, in a simple, i.e., a regular or a random environment, the knowledge an individual acquires in one place is easily transferable to other places. If the individual leaves a place, his absence is not particularly costly because when he returns the value of his previously acquired knowledge is largely intact. Thus, in the extreme instances of predictably regular (even with stochastic variation) and predictably random environments – two states almost universal in mathematical and statistical models of resource systems (Weaver, 1948) – both search and communication carry no opportunity cost (Fig. 1). Therefore, all individuals hold the same knowledge and there is little to gain from communications with any other individual. Consequently, social structure does not develop. The theoretical circumstances of perfectly competitive markets for homogeneous products are a good example of the social and economic outcomes that might be expected with low or zero information costs.

In a patchy, irregular and dynamic environment, on the other hand, an individual bears a higher cost when leaving a place. When he returns after an extended absence, he is likely to find that the practical value of his previously acquired knowledge is greatly diminished and that the cost of becoming current again is high. In this kind of environment, it is worthwhile for an individual to remain close to home, maintaining persistent communications with individuals and a group if other circumstances permit.

In short, the balance individuals choose between the autonomous search for knowledge and the acquisition of knowledge through communication with others works out in different ways (Fig. 1) depending on the dynamics of the resource they are exploiting. Generally, in simple environments, e.g., the kind of large, predictably regular or predictably random environments of standard fishing theory, the costs of individual search are low; as a result, the benefits of familiarity are low and individuals find little value from associations with others. If groups form, they are large and diffuse. On the other hand, in complex rapidly changing environments in which useful knowledge tends to be localized and ages quickly, the costs of information and the

⁴ Our argument is similar to Williamson's (1985) argument about the importance of asset specificity. The principal difference is that we emphasize knowledge of the resource as the pertinent specific asset.

³ By social structure we mean persistent individual and group relationships.

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