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Synthesis

The action cycle/structural context framework: a fisheries application

D.G. Webster [1]

ABSTRACT. There is a growing consensus that environmental governance is a wicked problem that requires understanding of the many linkages and feedbacks between human and natural systems. Here, I propose an action cycle/structural context (AC/SC) framework that is based on the concept of responsive governance, in which individuals and decision makers respond to problems rather than working to prevent them. By linking agency and structure, the AC/SC framework points out two key problems in the realm of environmental governance: the profit disconnect, whereby economic signals of environmental harm are dampened by endogenous or exogenous forces, and the power disconnect, whereby those who feel the costs of harm are politically marginalized and so have little influence to effect solutions. I apply this framework to fisheries to develop hypotheses regarding exclusionary and conservation-oriented responses under different power/profit dynamics. These expectations are tested in a historical case study of management of the lobster fishery in Maine. The analysis confirms the importance of profit/power dynamics and reveals that governance tends to go through effective and ineffective cycles in a management treadmill that can be driven by internal or external forces. The latter in particular are generally ignored in fisheries management but could ultimately undermine sustainability even in previously well-managed systems.

Key Words: *complexity; environmental governance; fisheries; social-ecological systems*

INTRODUCTION

Ideally, environmental governance should be proactive but in many issue areas resource users and decisions makers respond to problems rather than preventing them. Webster (2009) calls this responsive governance and further posits that decision makers first select expedient policies and then try more costly measures if problems persist or escalate. Figure 1 is a simple overview of this process. It starts with an environmental problem on the left-hand side of the figure eight. As long as management remains ineffective, the problem will cause increasing economic costs, which in turn will generate growing political concern. As pressure to respond increases, decision makers try new solutions until they effectively "solve" the underlying problem, switching the system into an effective cycle of environmental improvement. Some systems may not switch from ineffective to effective cycles in time, resulting in environmental catastrophe. There are also many exogenous and endogenous factors that can alter the behavior of the system. The action cycle/structural context (AC/SC) framework and related profit/power dynamics presented here are designed to improve our understanding of responsive governance with a particular focus on factors that either speed up or delay response.

Using the framework described below, two major delaying factors are clear. First, there is the profit disconnect, which occurs whenever economic signals regarding environmental harms are dampened. In other words, a profit disconnect occurs whenever the economic equilibrium level of production is greater than the sustainable level. Second, there is the power disconnect, which occurs when those who are sensitive to the costs of environmental damage are marginalized politically. Both disconnects change over time because of exogenous and endogenous factors and this can have profound effects on management. Indeed, they often amplify each other in a reinforcing feedback loop as greater wealth and economic importance increases the political influence of an actor, which in turn can be used to safeguard that wealth and forestall regulations that might limit profit seeking. The AC/SC framework also predicts that systems will cycle back and forth between the ineffective and effective cycles shown in Figure 1 in what can be thought of as a management treadmill. This treadmill can be relatively stable or it can be rapidly expanding around a positive trend, which increases the risk of catastrophic outcomes.

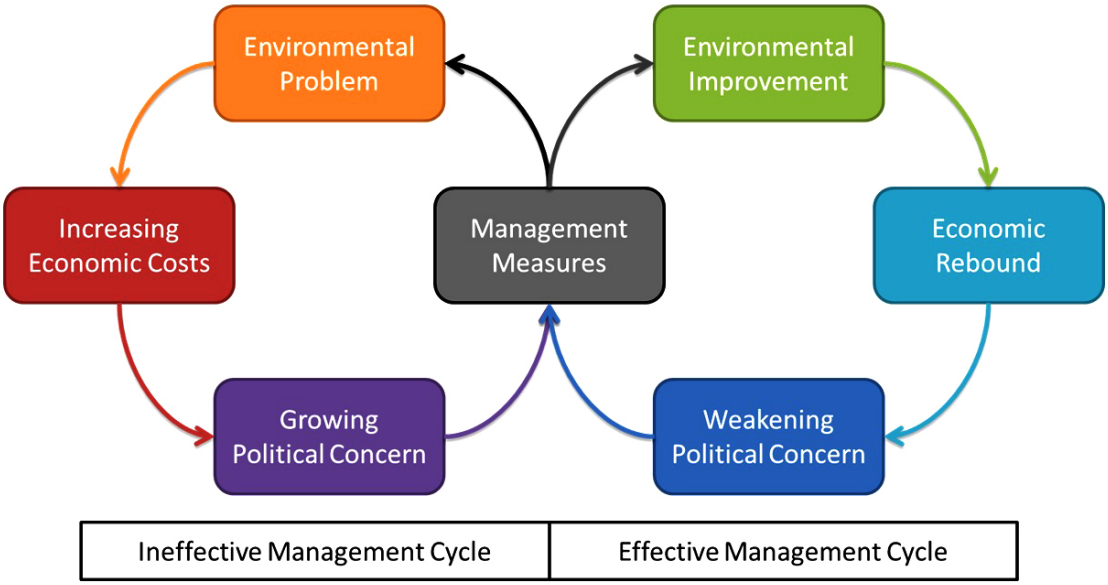
THE AC/SC FRAMEWORK

There is a longstanding debate in the literature on environmental governance between scholars who favor agency as a primary determinant of outcomes vs. those who ascribe greater influence to social structures. Young (2001) describes this tension as an argument between collective action vs. social practice approaches and finds that there is some truth in each perspective. Giddens (1979) approached the same problem in sociology by proposing that both agency and structure are important and that each reinforces the other. His theory of "structuration" accepts that actions can affect the institutional structure just as structure affects individual and group actions. The action cycle/structural context framework presented here was inspired by Giddens's theory of structuration but is founded in political economy and also draws on work from the literature on domestic and international governance, bioeconomics, and social-ecological or coupled human and natural systems (Simon 1955, Downs 1972, Newell and Simon 1972, Sprout and Sprout 1979, Higgs 1987, Hilborn and Walters 1992, Grossman and Helpman 2001, Baumgartner et al. 2009). As such it fits into a growing literature on middle-path approaches to the action-structure debate in the social sciences and policy studies more broadly (Steinberg 2012). Furthermore, the AC/SC framework should be thought of as a compliment rather than a substitute for existing frameworks for understanding social ecological systems, particularly Ostrom et al. (2007), Ostrom (2009), and Young et al. (2006). The main difference is the responsive nature of decision making and relative importance of temporal dynamics in the analysis.

Although the general concept of structuration is very useful, it is necessary to further define agency and structure in terms that are applicable in an environmental governance setting. In particular,

[1]Dartmouth College

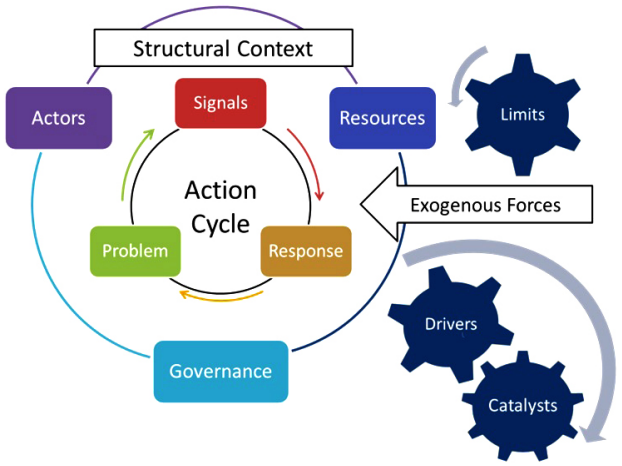
Fig. 1. Responsive governance cycles.



I associate agency with problem solving through an action cycle, where actors choose how to respond to signals that they receive about some underlying environmental problem. The nature of both the individual and aggregate response depends heavily on the structural context in which the action cycle takes place. Over time, however, responses in the action cycle can alter the structural context and thereby alter the behavior of the system as a whole. Figure 2 illustrates these points by embedding the action cycle in the structural context, indicating that action is constrained by the structural context but that the context is itself created by the compounding of actions over time. There are also exogenous forces that drive, catalyze, or limit the action cycle and which may operate at different "speeds" than the action cycle itself, as per the panarchy concepts put forth by Gunderson and Holling (2002; see also Ostrom 2004, Young 2010).

First, the action cycle consists of a problem, which generates signals, which in turn trigger actor responses. For instance, pollution (the problem) can cause negative health effects (the signal) which generates political action (primary response) and, where power favors those harmed, regulatory action will be a key result (secondary response). Primary and secondary responses may help to solve problems but can also simply dampen signals, allowing problems to become worse over time; both the profit disconnect and the power disconnect are widened by maladaptive responses that minimize problem signals without solving the core problem in a system. For example, many economic responses to problem signals such as the increasing marginal cost of resource extraction involve innovation to reduce costs of production. This dampens the signal of economic costs but does not expand the amount of the resource available or trigger switching to substitutes, so the core problem continues even though the primary problem signal is temporarily nullified by endogenous responses. This is an example of a profit disconnect. It will persist as long as technological change ensures that increasing costs of production (problem signal) can be mitigated by innovation (primary response). This persistence in turn depends heavily on the resources available in the structural context.

Fig. 2. The action/structure framework.



As per Young (1994), governance factors in the structural context include formal laws, regulations, and agencies, as well as informal rules and norms governing actor behavior. Actors themselves are also a part of the structural context because institutions circumscribe the roles and resources available to them. Actors may be individuals, groups, or states, depending on the case under consideration and the needs of the researcher. Indeed, the AC/SC framework is designed to analyze cross-level interactions, because response at one level of analysis is often aimed at altering responses at other levels. As in the pollution example described above, the primary response at the individual level was to demand

a secondary response from government, which could occur at the local, regional, or national level. Secondary responses can then feedback through the system, altering individual- or state-level behavior. In formulating their responses, actors depend on available resources, which include natural resources, capital goods and finance, technological and managerial capacity, and political power bases.[1] Where resources are limited, the responses of actors and the operation of the system as a whole are also limited, unless actors can find viable means of expanding the resource base. Economic responses such as the innovation described above often expand one type of resource (technology) through use of a different type of resource (capital).

All of the above factors are considered to be endogenous to the AC/SC system. However, there are other factors that affect the action cycle or alter the structural context and change the speed of response exogenously (Mitchell 1994, Young 2010). These generally fall into two major categories: limits and drivers. The latter can be further broken down into direct drivers and catalysts of change. Exogenous limits are forces that slow or stop the action cycle. They may be related to governance, economics, or natural systems and include institutional interplay, macroeconomic policies, and biophysical factors such as finite reserves of nonrenewable resources and replenishment rates in renewable resources. Ecosystem effects in particular are important limits when dealing with living resources like fish and other marine fauna. Exogenous drivers are forces that increase the speed and intensity of the action cycle. Like limits, these drivers can be related to governance, as when governments choose to subsidize economic development, economics, as when economic development drives increasing production, or the environment, as when changes in oceanographic conditions improve the productivity of a stock of fish. Technological innovation that is not associated with the action cycle directly but is appropriated by actors can also catalyze change. Sometimes, these shifts mitigate the underlying problem but more often technology drives expansion by reducing the costs of production.

Both endogenous and exogenous factors have some impact on the timing of transitions from the ineffective to the effective cycles shown in Figure 1. The timing of the switching response is different from the speed of the action cycle. Speeding up the action cycle means that problems worsen more quickly than they would otherwise, so that problem signals should escalate faster. This can generate response that occurs earlier in time but actually later relative to underlying problems. That is, with a faster action cycle, switching from the ineffective to effective cycles in Figure 1 will occur when problems are worse than in a slower action cycle, even though there is less time between the initiation of the problem and the implementation of a viable solution. Speeding up the switching response entails ensuring that solutions are in place when problems are relatively small and manageable. Thus, in a system where the action cycle is slow, for instance, in a small artisanal mining operation, effective response may occur after many years of exploitation but still be earlier than a case where switching occurs after 1-2 years but exploitation is undertaken by large industrial corporations. In the latter case, the amount of pollution or degradation that occurs in the ineffective portion of the action cycle is greater than the former case, even though the period of ineffective management is much shorter.

Both the profit and power disconnects delay switching responses by dampening problem signals and the political will to solve core problems. Within the action cycle, as per Webster (2009) it is assumed that decision makers, those actors who control the rules and norms related to the core problem, generally prefer expedient responses and so engage in trial and error or responsive governance as described above (Downs 1972, Ludwig et al. 1993). Political expedience depends on (1) the costs and benefits of policy options, which shape political demands for or lobbying against government response, (2) the relative political influence of actor groups, which determines their ability to impact government response, and (3) the goals of the decision making body, which impacts interest group influence and can generate exogenous changes in government response. Policy options that provide benefits to all actor groups are highly expedient and should be fairly easy to implement as long as they do not conflict with the goals of the decision making body, e.g., undermine their power base. In contrast, policy options that are costly to one or more groups will only be expedient if negatively affected groups have little political influence. Where groups with competing interests are equally powerful, there are few expedient outcomes and stalemate is a frequent response. As long as problem signals are low, only expedient management measures will be adopted when power is evenly distibuted.

It is also important to remember that expedient measures are often ineffective and may even speed up the action cycle. In such cases, core problems should persist or worsen, generating increasing political will to adopt less expedient solutions. Indeed, where relatively effective management measures are politically costly, there will be considerable delay in the transition from ineffective to effective management shown in Figure 1. Exogenous factors can also delay the switching response, particularly if they increase either the profit disconnect or the power disconnect. For instance, an exogenous increase in demand for a specific type of product can cause an increase in price that would counter the economic costs associated with higher levels of quantity supplied due to innovation. Alternately, shifts in the governance system, for instance from a democracy to an authoritarian system or even simply changes in laws that favor privileged groups can widen the power disconnect, allowing greater resource appropriation by outsider elites who have little incentive to sustain the resource base or invest in the local economy. Exogenous factors that speed up the action cycle can also destabilize response, because individuals and decision makers have less time for the trial and error process of responsive governance. This temporal disconnect magnifies most problems in environmental governance, including the profit and power disconnects.

Although there are many factors that delay or destabilize responsive governance, there are also forces that can speed up response relative to the severity of underlying problems. Within the action cycle, any process that narrows the profit disconnect will probably cause response to occur when the environmental problems are smaller and economic costs are lower. When economic signals clearly reflect underlying problems, we can expect exit from an industry and switching to substitutes. These primary responses reduce problems like resource degradation and pollution but are uncommon because so many strategies are available to avoid profit signals. Political will for regulation should also increase sooner when the profit disconnect is narrow,

although the effects of this dynamic are heavily dependent on the structural context as described above. Similarly, factors that narrow the power disconnect can generate earlier political response when there is sufficient overlap between actor goals and values. However, empowering sensitive actors can also cause political deadlock, further delaying response. Thus, structural shifts can also affect the timing of switching response.

Endogenously, political responses in the action cycle can alter the structural context by changing actor roles, available resources, and governance. This process is often called institutionalization. It can speed up response to similar problems in later time periods and even in related issue areas. Ostrom (1990) and many others describe this process in collective action settings. In formal governance settings, the formation of institutions or agencies modifies the governance mechanisms that circumscribe the system (Higgs 1987, Pierson 2000). For instance, the U.S. Environmental Protection Agency was created in part as a response to several well-publicized pollution crises but it was not disbanded once those problems were solved. Rather, it remains as a key component of pollution regulation in the United States. The institutionalization of response is not always beneficial; maladaptive responses can be institutionalized. However, it does provide an avenue to increase the speed and effectiveness of response through changes in the structural context. As per Young (2002), exogenous forces can have similar effects on the speed of response, particularly when a response in one issue area alters governance institutions or increases management responses more broadly. This can occur as vertical interplay when effects cross levels of analysis (i.e., when a major problem at the local level engenders national-level change in regulations) or horizontal interplay when effects occur at the same level of analysis (i.e., when a new regulatory option is developed in one location but then is adopted elsewhere because of its perceived success).

The AC/SC framework can be used as a deductive or inductive tool. It can guide descriptive analysis in an iterative process that starts with the definition of the core problem(s) and identification of the time period covered by the analysis. Usually, analysis should start with the beginning of human activities that generate the core problem. For instance, if a certain type of pollution is the core problem then the analysis would start with the development of the technology that generates this pollution or its introduction into a new area. The analyst then describes the various factors in the structural context and action cycle at the start point, along with any exogenous limits or drivers. Process tracing can then be used to document changes in the action cycle, its effects on the structural context, feedbacks between action and structure, and the overall system-level capacity for responsive governance. Throughout, exogenous factors should be monitored in case changes in these variables cause shifts in the system. Webster (2015) uses this approach to understand the evolution of global fisheries management generally.

Inductively, the AC/SC framework can also be used to formulate testable hypotheses regarding responsive behaviors. These can be aimed at specific levels of analysis or the working of the system as a whole. For instance, responsive governance itself can be tested qualitatively or quantitatively by collecting and comparing data on the temporal paths of the core problem and shifts in governance. The expectation would be that that governance does not occur prior to environmental problems, even in cases where institutions are well established and ample warning is provided by scientists or other actors. A corollary here is that, when response occurs, we would expect that more expedient measures are undertaken first and less expedient measures are only tried if problems persist. Webster (2009) uses this approach based on a much simpler framework. Similarly, the management treadmill is an extension of the responsive governance assumption and can be tested by determining whether or not governance does indeed transition between periods of greater and lesser effectiveness, either for the same specific problem or for different variations on the core problem. Alternately, one can develop hypotheses regarding interactions between framework components, such as how the structural context or exogenous forces affect signal reception and response choice within the action cycle, as described below.

AC/SC APPLICATION TO FISHERIES

The action cycle for most marine fisheries is dominated by the common pool resource problem (Ostrom 1990, Barkin and Shambaugh 1999). That is, because marine living resources are both open access and rival, fishers have strong incentives to take as many organisms ("fish" from here on out) as possible before they are harvested by others. This leads to the classic problems of overfishing, where effort is greater than that which would support maximum sustainable yield (or ecologically sustainable yield for that matter), and overcapitalization, where investment in effort is greater than the economically optimum level. Although both of these outcomes are undesirable from biological or economic perspectives, both may be limited by the profit signal, in which profits decline with increased supply and decreased biomass. All else equal, this dynamic should cause effort to increase until the system eventually reaches an equilibrium where total revenue = total cost and there is no longer incentive to increase effort (Clark 2005). In the language of the AC/SC framework, the profit signal is the primary endogenous determinant of actor response and, under open access, we generally expect a substantial profit disconnect. The profit signal can further be divided between the cost signal, which occurs when costs of production increase because of declining biomass, and the price signal, which occurs when prices decline with large increases in harvests (assuming the fishery is large relative to the market).

As shown below, the *ceterus paribus* or all else equal assumption does not often hold in commercial fisheries and the profit signal is frequently obscured as endogenous and exogenous factors widen the profit disconnect by causing the economic equilibrium level of production to shift out without increasing biological productivity. Endogenously, the fishing industry itself often responds to lower profits by investing in innovation to reduce costs and/or drive up demand, thereby keeping profits high in spite of declining biomass and increasing supplies of fish products. The cost signal associated with declining biomass can be mitigated through exploration and technological innovation, both of which increase resources available in the structural context and dampen incentives to reduce effort regardless of the property rights regime (Squires et al. 2008, Squires and Vestergaard 2013). These types of responses can cause massive increases in production, which would drive prices down if the all else equal assumption holds. However, fishers and other industry actors frequently counter this price signal by working to expand markets,

generating growth in demand to match or exceed growth in supply. Without these primary economic responses and related dampening of regulatory response the fishing industry could not be as large and widespread as it is today.

When governance is included in the analysis, the AC/SC framework highlights different problems, signals, and disconnects. First, conflict over access rights is a political problem that is often ignored in economic theory related to fisheries but is a major driver of early response through the establishment of endowments and entitlements (Ostrom et al. 1994). Historically, many fishing communities managed their local stocks through allocation of use rights, defending "their" fisheries with physical violence when necessary. In modern times, because open access is the dominant norm, fishers frequently use conservation as a pretext when they lobby for exclusionary regulations that force outsider groups of fishers to reduce their effort without negatively impacting insider groups. Gear restrictions and time area closures as well as quota schemes can all be used as indirect exclusionary tactics.

In contrast, environmental interest groups and recreational fishers are political groups that tend to respond to biological signals as interpreted by scientists and the media, though their response also escalates with the core problem and so may not be very strong until a stock is severely depleted. These groups often prefer stringent conservation measures that impose high costs on fishers and the industry as a whole. This can lead to strong ideological backlash by industry and the resulting conflict between powerful interests often results in regulatory inaction due to political stalemate. However, if the costs of overfishing increase with delayed response then increasing political will to find solutions can foster coalition formation and the eventual implementation of more effective management measures, switching the system to the right-hand side of Figure 1 (DeSombre 1995). Alternately, when powerful industry groups are insulated from costs by the profit disconnect, then coalition formation is unlikely and collapse is an expected result unless conservation groups can leverage public support (in democracies) or other sources of political power.

Decision makers themselves are actors in the AC/SC framework. They have their own goals and resources. Maintaining or increasing their political power and economic resources is a common goal for decision makers. It can be driven by personal greed or by the desire to increase problem-solving capacities. Other goals that are related to fisheries include conflict prevention, food security, economic development, and employment as well as sustainable management. In fact, conservation is a relatively new goal for government decision makers in the fisheries arena; government regulation to maximize the short-run socioeconomic benefits of fishing has a much longer history. Most of these goals can be met in the short run by the economic expansion of the fishing industry, and so early governance responses in industrialized fisheries feature policies such as subsidies and size limits, gear restrictions, or other expedient regulations that are supposed to provide some conservation without substantial negative effects on total catch and related economic benefits. In many areas around the world, decision makers also responded to conflicts among fishers by establishing access rights and judicial processes. Well-enforced measures like catch limits are usually the least expedient policies and so are only adopted when both the profit disconnect and the power disconnect are small due to widespread overexploitation, lack of economic responses that mitigate the profit signal, and exogenous factors as described below.

Hypotheses derived from the above analysis are summarized in Figures 3 and 4. Figure 3 describes broad response expectations depending on the state of the profit disconnect and the distribution of power among key actor groups. When the profit disconnect is narrow, fishers are sensitive to bioeconomic problem signals, so if they are the most powerful interest group(s) then the power disconnect is narrow (row 1). On the other hand, if the profit disconnect is wide and fishers are the only powerful actors (row 5), then the power disconnect is also wide; thus the two disconnects are positively correlated if noncommercial interest groups and exogenous forces are not included in the analysis. However, the nature of response in either situation depends heavily on the distribution of influence between groups of fishers and so will be discussed in greater detail in the description of Figure 4.

When noncommercial interest groups are able to monopolize power in the structural context, then we can expect substantial limits on commercial fishing, including complete bans, and fairly rapid establishment of "genuine" conservation regulations that are at minimum well enforced and designed according to scientific advice. I use the term "rapid" instead of ""early" because it is rare for noncommercial interests to have significant political influence early in the action cycle, particularly not the monopoly on power described in this ideal-type. Usually biological problem signals must be quite strong for them to harness the power of the public as a latent interest group (Olson 1971). All else equal, when the profit disconnect is narrow, and fishers are also sensitive to bioeconomic problem signals (row 2), this response is likely to generate switching from ineffective to effective management cycles as shown in Figure 1. The International Whaling Commission from the late 1970s to the 1990s is probably the best-known example of this profit/power dynamic. However, if the profit disconnect is wide or increasing (row 6), then there are substantial incentives to fish in contravention of limits and conservation regulations, so we can expect wide-spread noncompliance by the fishing industry. There are many examples of this behavior in the area of charismatic megafauna generally, including widespread illegal trade in sea turtle products, shark fins, and multiple endangered species of coral (INTERPOL 2013).

Cases where noncommercial interests are able to monopolize power are rare throughout the history of fisheries management, particularly in marine systems. More often, fishers are the primary interest group(s) until stocks are severely depleted, triggering strong action by noncommercial interest groups. In such cases, both commercial and noncommercial interest can wield considerable influence. This always causes initial conflict, largely because noncommercial interests usually call for drastic limits on fishing effort, which threatens fishers' livelihoods. If the profit disconnect is narrow (row 3) then this period of conflict may be quite short, causing only a short delay in conservation-oriented management. A caveat on this response is that conflict over access rights among fishers can delay response regardless of the profit disconnect (see discussion of fig. 4). If the profit disconnect is

Fig. 3. General power/profit dynamics.

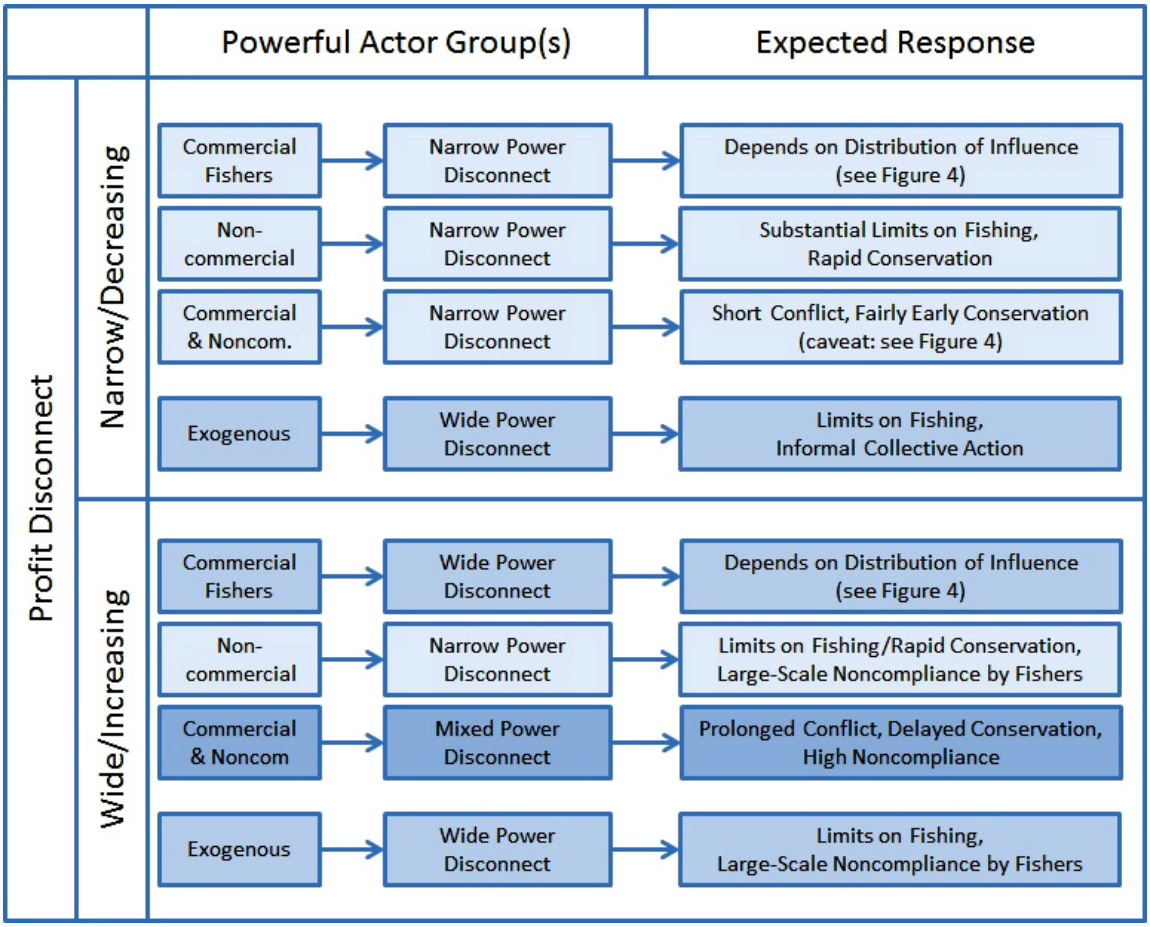


Fig. 4. Predicted responses when fishers are the only powerful actors.

		Profit & Power Disconnect	
		Narrow/Decreasing	Wide/Increasing
Distribution of Influence	Uniform	Collective Action	Prolonged Conflict
		Early Conservation	Delayed Conservation
	Asymmetrical	Early Exclusion	Delayed Exclusion/ Prolonged Conflict
		Delayed Conservation	Severely Delayed Conservation/Collapse

wide (row 7), then prolonged conflict will probably delay a genuine conservation response, although it is likely that governments will adopt some weak measures to placate both sides. Even when stronger measures are in place, high levels of noncompliance can be expected because incentives to cheat are high as long as the profit disconnect is wide. Management of Atlantic bluefin tuna is a good example in this category (Webster 2011).

Last, for Figure 3, it is important to note that exogenous interest groups, either from other fisheries or completely unrelated to fisheries, may have considerable control over regulation in a given fishery. For example, issues like security, oil production, or trade and commerce take precedence over fishing in many parts of the world. Similarly, formal and informal hierarchies can marginalize fishers politically even when they are profitable economically. In such cases the power disconnect is always wide, because exogenous groups do not receive problem signals from fisheries at all. Nevertheless, the impact of these groups can be substantial. In general, we expect that fishing will be prohibited in any areas where there are conflicts with exogenous uses, such as near ports, beaches, or oil rigs. Otherwise, conservation is not likely to occur formally, though when the profit disconnect is narrow (row 4) fishers may develop informal sharing arrangements among themselves (again, see discussion of Figure 4). Alternately, if the profit disconnect is wide (row 8), then wide-spread noncompliance with these limits can be expected and it is likely that severe depletion will result, particularly outside of conflicted areas.

Figure 4 provides greater detail on fisheries where commercial fishers are the only powerful interest groups. It outlines expected responses given the combined power/profit disconnect (columns) and distribution of influence among groups of fishers (rows). Rows are further divided into response to conflict signals (top) and response to profit signals (bottom). In general, conflict signals are expected to occur earlier than profit signals and so conflict responses can be expected to precede profit responses, although token conservation measures that are not likely to have much effect on the stock or the fishery may be adopted fairly early. All else equal, when both the profit disconnect and the power disconnect are narrow and influence is uniformly distributed (box 1, upper left), the primary conflict response is collective action and we can expect relatively early conservation response to bioeconomic problem signals. More specifically, collective action will involve exclusion of outsiders to prevent entry and distribution of access rights to reduce conflict among existing resource users. Similarly, because those with power are sensitive to bioeconomic problem signals, relatively early conservation response is expected. That is, governance will still be responsive but actors will press for conservation soon after problem signals start and will agree on measures before substantial biological depletion sets in. Conflict over access may delay conservation somewhat but is less likely than in other categories because all fishers are equally affected by the narrow profit disconnect.

Alternately, when the profit/power disconnects are wide and power is distributed uniformly among groups of fishers (box 2, upper right), prolonged conflict is likely because bioeconomic signals are delayed and no groups are able to exclude others. Two exceptions are rules excluding outsiders (who usually wield little political power) and token conservation measures as described above. Otherwise, groups of fishers will not be able to agree on access rights or genuine conservation measures until bioeconomic problem signals are experienced, and because the profit disconnect is wide this will substantially delay both types of response. Interestingly, conservation-oriented response is also likely to be delayed when the profit/power disconnects are narrow and distribution of power is asymmetrical (box 3, lower left) but for different reasons. Here, less powerful groups of fishers will be excluded fairly early in the action cycle because there are strong bioeconomic problem signals. Hypothetically, remaining groups should then be able to negotiate conservation measures as in box 1, but this rarely happens. On the one hand, remaining groups often overestimate the "room to grow" created by exclusion, so overcapitalization ratchets up quickly, making conservation more difficult. On the other hand, the process of excluding week actors tends to undermine the legitimacy of management generally and can prolong conflict among remaining actors in spite of strong bioeconomic problem signals.

Last, for Figure 4, when the power/profit disconnects are wide and influence is distributed asymmetrically (box 4, lower right) prolonged conflict and severely delayed management response is expected. In such cases there are usually strong reinforcing feedbacks between profit and power that constantly increase the profitability and political power of capital-rich members of the fishing industry while further marginalizing less wealthy and more vulnerable fishers. Counterintuitively, political exclusion tends to be delayed in these cases because powerful actors are not threatened by less powerful groups economically. Large industrial fisheries corporations may even avoid exclusionary regulation because it might set a precedent that could limit their future growth. On the other hand, smaller scale fishers may lobby to exclude large-scale fleets but because they lack political power their efforts will not result in exclusionary regulation.[2] As with box 2, because bioeconomic problem signals are delayed by the wide profit disconnect, we can expect delayed conservation in this category. However, because of the reinforcing feedback loop noted above, the profit disconnect is increasing, which constantly pushes the equilibrium level of effort farther from the sustainable level and creates a prolonged period when bioeconomic problem signals are dampened for politically powerful actors. Because of this, conservation response will be severely delayed and may not occur until the fishery actually collapses, either economically or biologically.

In addition to the ideal-types shown in Figures 3 and 4, the AC/SC framework points out two other sets of factors that can affect the timing of governance response in fisheries. First, within the four boxes shown in Figure 4, any component in the structural context that increases the expedience of relatively effective measures can improve the speed of conservation response and vice versa. These factors include development of expedient yet effective management measures (resources), strong leadership (actors), and legitimate institutions (governance). Most of these factors are already well-understood in the literature. However, they do not over-ride the expectations developed in Figures 3 and 4. Rather, these factors fine-tune response within each category. That is, when both disconnects are narrow, we still expect early conservation response but it will occur sooner with a conducive structural context and slightly later with a prohibitive structural context. Similarly, when either disconnect is wide, conservation response will still be delayed more than in cases where both disconnects are narrow, but the length of delay will vary based on the favorability of the structural context. When both disconnects are wide even a highly favorable structural context will have little impact and, indeed, we can expect to see deterioration in certain factors such as leadership and legitimacy as conflict and contestation undermine confidence in the system. Thus structure affects action but action also impacts structure.

Second, any factors that alter either the profit disconnect or the power disconnect can switch a system from one category to another and thereby alter response. Endogenously, entrepreneurial behavior by fishers and others in the fishing industry tends to reduce costs of production, expand sources of revenue to multiple stocks or fishing grounds, and increase market demand for fish products. Indeed, the industry is adept at minimizing both cost and price signals, which widens the profit disconnect and can shift a system from the left to the right-hand side of Figure 4. Interestingly, capital agglomeration can lead to a shift in the power disconnect as greater production is associated with increased influence in terms of food supply, employment, lobbying, campaign contributions, and other factors that can sway decision makers. Industry demands for supporting subsidies or other expansionary measures can amplify the positive feedback between the profit disconnect and the power disconnect as well. In contrast, regulations that limit ownership and exclude large corporate fishing interests can help to maintain a narrow profit

disconnect. These most often emerge in pluralist systems where small-scale fishers can utilize the power of numbers to influence government policy.

There are several exogenous drivers that can shift a system from one category to another in the Figures. Population growth and economic development both generate increasing demand that allows prices to remain high on average in spite of increases in supply, dampening the price signal and widening the profit disconnect (Sumaila et al. 2007). Globalization and technological innovation catalyze lower costs of production, dampening the cost signal (Squires and Vestergaard 2013). On the other hand, macroeconomic factors like economic recession can narrow the profit disconnect by causing prices to drop. This in turn can generate considerable political will for improved management regardless of the biological state of a fishery. Politically, recessions, war, and similar disturbances can exogenously drive governments to create subsidies to develop new fisheries to ensure food security and economic growth rather than as an endogenous response to fisher lobbying (Royce 1987, Clark et al. 2005, Sumaila et al. 2010). Similarly, when fisheries are seen as a source of wealth, governments or states may seek control over fisheries resources, reducing direct competition for their domestic fleets independent of fisher demands for protection (Fulton 1911, Juda 1996). Ultimately, any change in the governance structure that increases the political power of sensitive actors will reduce the power disconnect while factors that marginalize sensitive groups widen the power disconnect.

CASE STUDY: MAINE LOBSTER GOVERNANCE

The case of the Maine Lobster fishery was selected for several reasons. First, it is relatively simple, with little involvement of noncommercial interest groups, so the focus can be on the expectations put forward in Figure 4. Although it is important to test all of the implications of the AC/SC framework described in Figure 3, space constraints limit the analysis. Here, the main purpose is to show how the expectations above can be tested, rather than test all of them. That said, the second reason the Maine lobster fishery was selected was because all four of the major ideal-types presented in Figure 4 are represented at different periods in its history. Third, many of the most common endogenous or exogenous forces that can shift fisheries from one category to another are demonstrated in this case. Fourth, as one of the most well-studied cases of environmental governance, the Maine lobster fishery provides a test of the value added of the AC/SC framework generally and the hypothetical profit/power dynamics derived from it. I argue that this approach is more generalizable than existing explanations of governance in these fisheries and that it provides a unified perspective that encompasses the pre-existing literature rather than replacing it. Furthermore, the framework explains stability as well as change, providing the theoretical groundwork for expectations of periods of delay as well as periods of response.

The approach used here is qualitative, partly because long time series of quantitative measures are not available for all of the key variables, especially the profit and power disconnects, and partly because a focus on detail is appropriate at this stage of theory development. In the analysis, I use the academic literature augmented with contemporary news articles, market reports, and government documents to trace changes in the profit disconnect and the power disconnect over time. This allows me to break each case down into time periods that match up with the different categories in Figure 3 and also to identify the various factors that drive switching from one category to another. Once the periods are classified, I test whether or not governance fits the expectations derived from the AC/SC framework given the relevant profit/power dynamics as described above. This is also a test of the existence of responsive governance generally, because it traces the action cycle and shows how response changes over time in each period.

Although widely viewed as a great success in terms of both collective action and government regulation, in reality the lobster fishery of Maine cycled through several periods of overexploitation and rebuilding. These cycles were shaped by economic, political, and biological forces and each engendered a different process of response depending on the profit/power dynamics of the period. As with most fisheries, the Maine lobster fishery started out with a narrow, or even negative, profit disconnect and equally narrow power disconnect. This changed over time as first canneries and then dealers in fresh lobster injected capital into the fishery, widening both disconnects, at least temporarily. Exogenous forces also came into play as increasing or decreasing demand had profound effects on management, as did influxes of new fishers when managers reduced access to other fisheries, including the New England groundfish fishery. Thus, both conflict and profit signals were at play during different phases in this history of this fishery.

1800 to early 1840s

The commercial fishery for lobster in Maine started at the beginning of the 19th century. Although lobster were plentiful, methods of capture were rudimentary and preservation technologies limited markets, so there was a narrow or even negative profit disconnect in the early 1800s. The introduction of the welled smack-a vessel that could carry live lobsters to ports like Boston increased the equilibrium level of production but the profit disconnect remained narrow until the growth of canneries in the 1840s. Lobstermen, too, were primarily of the same social class and, although there were certainly hierarchies within communities, the power disconnect was narrow because all were equally affected by changes in the fishery (Formisano 1997). Thus, for its first 40 years the Maine lobster fishery fit in the top left hand box in Figure 3 and we would expect to see collective action to exclude outsiders and share the resource among insiders, as well as early conservation if any such measures were even necessary given the level of exploitation and capitalization in the fishery.

Analysis of formal governance fits these expectations. With the introduction of welled smacks, fishers from New Hampshire, Massachusetts, and even Canada started harvesting lobster in the Gulf of Maine. This angered local fishers who lobbied for exclusionary regulations in the 1820s. In 1828, the Maine legislature passed a law prohibiting landing of lobster by out-of-state vessels, effectively closing off the fishery to outsiders. Informal governance is more difficult to analyze because there are few written records of it from the period. Given the rapid growth that started with the introduction of smacks, it is possible that conflict between increasing numbers of fishers led to establishment of what Acheson (1975) refers to as perimeter-

defended territories, where groups of lobstermen established well-defined boundaries to fishing territories near their home ports. Certainly, Acheson notes that these types of territories were most prevalent prior to 1920. Nevertheless, I could not find written evidence of such access rights in the early 1800s, and so can only speculate. In contrast, a number of sources describe vast quantities of lobsters and high profits in the fishery, so without either catch or profit signals, we do not expect early conservation-oriented regulations and none are observed in the historical record. Thus, this period is a fair match for the expectations presented in Figure 4.

1840s through early 1870s

The first cannery for lobster opened in Maine in 1842 and the industry grew rapidly thereafter, peaking around 1865 (Cobb 1899). This generated growth in both the profit disconnect and the power disconnect. First, canning opened up inland and international markets for lobster, which were growing because of both population growth and economic growth associated with industrialization in Europe and North America. Demand for fresh lobster was also increasing during most of the period, though at a slower rate, so there was also a profit disconnect in that fishery as well. Second, the influence of canneries grew in parallel to their economic growth. Both employment and food security were important issues at the time, in Maine and elsewhere, so the shore-based employment and high levels of production were desired by decision makers. Moreover, canners were fewer in number than fishers, with close network ties, making it easier for them to organize to lobby the Maine legislature. Because canners preferred small lobster while fresh lobster markets required large lobster, canners were less sensitive to the effects of overfishing, which were mainly signaled through a decline in the average size of lobsters found in the Gulf of Maine (Acheson 1997). Thus, the power disconnect was wider in this period than previously, though not as wide as in other fisheries. Given that both disconnects were increasing and the distribution of power was asymmetrical, the fishery fits within the lower right-hand box in Figure 4 and we would expect that all response would be delayed but that canneries would work to exclude the fresh lobster industry once bioeconomic problem signals started. Conservation is not expected to occur until bioeconomic crisis is experience by the more powerful actor group (canneries).

Landings in both the fresh and canned fisheries increased substantially over this period and biological signals of overfishing started in the 1860s, because lobsters were noticeably less plentiful in near-shore areas and the average size of landed lobsters declined substantially (there is also selection bias here, as canners preferred small lobsters). By the 1870s, lobstermen, canners, and government officials all expressed concern regarding declining lobster catches and increasing conflict over the diminished resources by cannery and fresh lobster interest groups (Cobb 1899, Acheson 1997). In 1872, the legislature did take some conservation action by banning harvests of female lobsters carrying eggs. This was an expedient measure because it was popular with all sides and was not enforced or followed. However, canneries also lobbied for indirect exclusionary measures against the growing fishery supplying the fresh lobster trade. Although this fishery was small relative to canning in the 1850s and 1860s, it started growing rapidly in the 1870s as new transportation technologies allowed for the expansion of markets to areas far from fishing grounds. Because of this increasing competition, canneries started to loose profits. Responding to both economic and political problem signals, the canneries lobbied the Maine government for exclusionary regulation toward the end of the period. They were eventually successful and in 1874 the Maine legislature passed a bill that set a maximum size for lobsters from fall through spring (Acheson 1997).

Although the 1874 regulations may sound like conservation measures to an outsider, it is important to note that lobster was only canned in the summer months and that the canneries preferred small lobsters that were not yet reproductively mature. In contrast, lobstermen who supplied fresh markets worked year round and received the highest prices for larger lobsters (Acheson 1997). Thus, the 1874 regulations are clearly exclusionary management measures that were designed to force fresh lobster fishers out of the fishery while having almost no effect on the canneries. Again, the economic effects of biological depletion were part of the driver behind the political demand for management but the canneries' political response to the perceived economic threat from the growing freshwater fishery was also important. However, although canneries were able to convince decision makers to pass exclusionary regulations, enforcement was lax and the exclusionary result was minimal. Lack of enforcement was partly due to the low levels of managerial resources available at the time but was also politically expedient, allowing for legal placation of the canneries without inciting violent protest from other lobster fishers or the markets that they supplied.

Late 1870s to 1880s

As demand increased with expanding markets, the fresh lobster fishery continued to grow throughout the 1870s and 1880s, reversing the distribution of profits and power. Whereas there were only 6 smacks transporting fresh lobster from Maine to Boston and New York in 1853, there were 58 by 1880 and 76 by 1898, including 17 that were steam powered rather than sail (Cobb 1899). In contrast, by 1880 the number of operating canneries fluctuated substantially with the size of the lobster harvest and many were already out of business. Declines continued in subsequent decades, until only 11 canneries still operated in 1902 (Cobb 1899). Thus, the profit disconnect was increasing for the fresh lobster industry but decreasing for the canneries. The power disconnect also shifted in this period. With growing numbers and substantial incentive to accept the transaction costs of organization, lobstermen and dealers who sold fresh lobsters organized to lobby for major changes in the 1872 legislation. They also mobilized the public against the canneries by highlighting the "wastefulness" of canning (Acheson and Gardner 2010). Note that this change in the distribution of political influence did not actually narrow the power disconnect. By this time canneries were more sensitive to bioeconomic problem signals than fishers targeting fresh lobster because of declining prices for canned lobster, but they were much less powerful. Thus, the fishery remained in the lower right corner of Figure 4 but in this period we expect the more powerful group (the fresh lobster industry) to exclude the less powerful, the canners. Conservation measures are still expected to be severely delayed.

Indeed, the industry supplying fresh lobster worked for a decade to reverse the 1872 legislation and finally won a sea change in

regulations that effectively excluded cannery lobstermen from the fishery in the 1880s. Here again, the official rationale for the new legislation was conservation but the actual impact of the new minimum size limit was to formally outlaw capture of lobsters of exactly the size preferred by canneries, indeed, the size that they needed to keep operating costs low enough to make a profit. Many blame these regulations for the demise of the canneries, though changes in demand played a role as well. Consumers reduced purchases of canned lobster as relatively cheap fresh lobsters became available. This "trickled" through the system and, by the 1880s, lobstermen could make much more money supplying fresh markets, so declines in the supply of lobster to canneries compounded the economic difficulties associated with decreasing demand. In the end, canneries could not survive both economic pressures and exclusionary regulations; they closed down while the fishery for fresh lobster continues to this day. There were no other attempts at conservation regulations in this period, so the evidence fits the expectations (Acheson 1997).

Late 1880s to late 1920s

Interestingly, with the exit of the canneries, power was distributed much more uniformly starting in the 1890s because only the fresh lobster industry remained. During this period, fishers had no one to exclude but themselves. On the other hand, the profit disconnect continued to widen, causing the power disconnect to escalate as well. With the exception of a short recession after World War I, prices for fresh Maine lobster increased while costs of production declined in spite of lower stock sizes due to technological advances, particularly the introduction of steam and then gas powered vessels around the turn of the century. Therefore, in this period the fishery fits in the upper right box in Figure 4, where the profit/power disconnects are wide/increasing but the distribution of power is uniform. Given this, we expect to see prolonged conflict over access rights and delayed conservation response until bio economic problem signals are felt within the industry.

Here again, expectations derived from the AC/SC framework are met by observed behavior. Scientists increasingly warned that the lobster stock was overexploited throughout this period and there was much debate regarding management. There was considerable path dependence as this debate focused largely on shifting the existing size limit. In 1907, the Maine legislature adopted a new size limit that was at once too high to allow fishers to harvest the highest-priced lobsters and too low to protect egg-bearing females. This compromise legislation was also not well enforced, so it fits the expedient but ineffective response that is expected when the profit disconnect is increasing and profit signals are weak. The size limit was changed again in 1919 but was still ineffective. Furthermore, those regulations that existed were blatantly violated by lobstermen throughout Maine (Acheson 1997).

Government-funded propagation of lobster through "seeding programs" was also popular in this period. Experimental attempts at seeding, or raising lobster fry in hatcheries and then setting them free in nursery areas along the coast started in the 1860s but took off after large-scale implementation at the Woods Hole Marine Laboratory in 1885. If it worked, this type of intervention would be expansionary because it would increase the size of the lobster stock. Interestingly, the hatchery program itself started a market for berried lobsters, which were sold to the U.S. Fish Commission for use in its hatcheries. Even here, exclusion was important and the Maine Legislature negotiated with the Federal Government to ensure that the vast majority of fry produced from Maine lobsters would return to Maine (Cobb 1899). However, "seeding" of marine species, including lobster, is not effective and eventually the program was shut down for lack of results (Commissioners on Fish and Game 1911). Nevertheless, government purchases of berried lobsters continued and in 1917 the Maine Legislature formally approved the practice of paying the operators of lobster "pounds" (large pens where lobster were held alive to smooth out seasonal fluctuations in supply), for their berried females. Note that this was during a brief recession in the fishery and so is in itself an expansionary response to narrowing of the profit disconnect. It was certainly much more expedient than enforcing the 1972 law banning harvests of berried lobster. It also started the practice of marking these lobsters with a hole in their tails and banning harvests of marked lobster (Acheson and Gardner 2011). This more conservation-oriented aspect of the 1917 program was not enforced and no other conservation measures were adopted during the period in spite of frequent warnings regarding the state of the stock from scientists. This continued as long as rising prices and improving technologies ensured that lobstermen could profit in spite of stock declines.

Late 1920s to World War II

Response remained conflicted and ineffective until a sudden exogenous change, the Great Depression, shifted the fishery back into the top left box in Figure 4, where both the profit and the power disconnect are narrow. During the depression, few people could afford an expensive commodity like fresh lobster, so demand declined precipitously. Because stocks were already heavily overexploited and the fishery was deeply overcapitalized, there was no way for lobstermen to avoid the economic impacts of this sudden change and profit signals spiked sharply. Given these changes and the existence of established local access rights, we expect that fishers would seek exclusion of outsiders and expansionary measures first but would quickly push for genuine conservation measures if these attempts failed to solve the core problems, in this case heavy overexploitation of the stock, overcapitalization of the fishery, and exceptionally low prices.

Interestingly, this was a period of substantial cooperation between the industry and government. The Maine Fish Commission, under the leadership of Horatio Crie, who first became a fish commissioner after a 1917 law that put in place a tripartite leadership system, worked with the industry to accomplish two goals in the 1930s: increase demand through a major advertising campaign and reduce supply by seeking tariffs on lobster imports from Canada. Hypothetically, these politically expedient measures (one expansionary, the second exclusionary) could bring prices back up without reducing harvests. However, demand did not increase with the new marketing campaigns and the Maine delegation could not convince the national government to impose tariffs on Canadian lobster. For the trade measures in particular, the Maine lobster fishery fits in the fourth row in Figure 3, where the profit disconnect is narrow but the power disconnect is wide because exogenous decision makers at the national level were much more concerned about factors other than fisheries and so ignored the lobbying by Maine lobstermen (Acheson 1997). This "nesting" of the structural context aside, both strategies fit

with expectations of fisher behavior, even though neither solved the core problems of the period.

Because marketing and protectionism were unsuccessful, even as palliative measures, attention turned toward altering the size limit for lobster to take advantage of the growing demand for medium-sized lobsters. Again, the lobster industry responded by working to alleviate the economic crisis without addressing the biological state of the stocks, as would be expected based on the AC/SC framework. Not everyone favored this approach, because the lower minimum size might open U.S. markets to smaller Canadian lobsters. Thus, the desire for exclusion of outsiders predicted in Figure 4 ensured that lobstermen and other industry interests were divided on the size limit question. This caused political stalemate that did not last very long, in part due to political entrepreneurship and in part due to the rapid escalation of problem signals in the fishery. The industry needed a solution if it was going to survive. Commissioner Crie provided them with cogent arguments for the establishment of a double gauge law to bring the stocks back at least cost to the industry (Acheson 1997).

In this instance, Commissioner Crie took the lead in establishing regulations that were at once economically beneficial for the industry and were based on sound scientific advice. Believing that a smaller size limit alone would be detrimental to the stocks and therefore to the industry as a whole, he favored a double-gauge limit. Following work by biologists in the late 1800s, Crie proposed that there should be a maximum size limit in addition to the reduced minimum size limit. This would protect the older adult lobsters that produced the majority of new eggs each season as well as juvenile lobsters that had not yet had a chance to spawn. This approach was not well received when introduced by Crie but he persistently lobbied the fishing industry and decision makers alike. Finally, the legislature adopted the double-gauge law in 1933 (Acheson 1997).

There is also evidence of additional conservation-oriented response without direct leadership. During the 1930s, lobstermen started to self-police the ban on private sales of berried lobsters, i.e., selling these lobsters to anyone but the State of Maine, or sale of lobsters marked as reproductive-aged females. Sales of berried lobster to the State of Maine for conservation were substantial in this period (60,000 lbs per year) and because the government paid market price this can be thought of as an industry support program as well as a conservation program. Indeed, it is highly expedient from the industry viewpoint because it is designed to conserve the resource and actually benefits pound owners and the lobstermen who supply them. Given that demand was low and costs were high, this extra source of income was important to the industry as a whole. Acheson and Gardener (2010) also point to the economic hardships of the time as drivers of a search for better management that would help to rebuild the stock, though they focus on declines in catch rates in their 2011 piece on protection of reproductive females via the V-notch law. It is likely that both problem signals were important, though catch per unit effort declined steadily in the early 1900s, and other signs of decline were clearly visible to lobstermen early in the century, so it is likely that the sudden narrowing of the profit disconnect was an important component in this shift (Commissioners on Fish and Game 1911).

Thus, both the double gauge law and pre-existing laws protecting reproductive female lobsters were either implemented or finally enforced during this period of narrow profit disconnect. Although this is an example of extremely delayed response when the depth of the overfishing problem is considered, it is exceptionally rapid when measured from the shift in the profit disconnect created by the Great Depression. Compared to the beginning of the 19th century, clear problem signals were received by fishers and response, although still not proactive, rapidly transitioned from pure exclusion and expansion to some level of conservation. Although this change in the profit disconnect created a window of opportunity, response may have taken a bit more time if not for several factors that made the double gauge law and related protections for reproductive females more expedient. These include the presence of a strong leader, Commissioner Crie, and the fact that legislation protecting the breeding stock already existed. However, these laws had existed for decades and Crie himself, along with several other decision makers, had worked to implement a license system and other conservation measures since the end of World War I, yet it was not until the profit disconnect closed that the industry finally accepted the need for some type of conservation (Morris 2008). When stocks and prices both started to rebound toward the end of the decade, this visual proof of the efficacy of these measures generated what Acheson (1997) calls a "conservation ethic," or at least a deep belief that the double gauge and other measures that were implemented during this period were absolutely necessary for the continued prosperity of the fishery.

Late 1930s through early 1960s

It is difficult to determine the state of the profit disconnect during World War II. Prices rose sharply with the increased demand due to the war but stocks had also rebounded, so problem signals were minimized. Furthermore, overcapitalization was alleviated by the exit of numerous lobstermen during the Great Depression and the departure of many young fishers who enlisted for the war. Lower competition, higher stock sizes, and improved technologies lead to a decline in costs of production, which amplified profits even further but again, entry was limited by war-time shortages of fuel, labor, and other resources, as well as fears of German U-boats. By the end of the war the lobster stock was substantially recovered, retail prices were high, and returning veterans swelled the ranks of lobstermen. Indeed, the number of lobstermen nearly doubled from 1940 to 1955, and then doubled again from 1955 to 1965. This would suggest a wide profit disconnect but landings stagnated, high retail prices were not matched by high ex-vessel prices (the amount paid to fishers), and costs of production were also increasing in this period, so for lobstermen the profit disconnect was still narrow (Formisano 1997). Economic power was clearly in the hands of the dealers for much of the period, but lobstermen could still wield the latent power of public opinion if they could overcome transaction costs and organize politically. From this, we can say that the fishery remained within box 1 of Figure 4.

The only conservation-oriented measure passed in this period was the 1948 V-notch law. This altered the manner of marking berried female lobsters from a hole to a V-shaped notch in the tail and codified the existing informal norm among fishers, who had started voluntarily marking these lobsters in the late 1930s. Although the government program to purchase berried females remained in place throughout this period, it was scaled back considerably and lobstermen caught more berried females than the state could buy (Lobster Research Project 1974). Instead of

scraping off the eggs and selling the lobster illegally, as they had in the past, a number of fishers started to mark these lobsters and then return them to the ocean, increasing the number of lobsters protected by law. Returning veterans in particular took up this practice and internalized this norm during the 1940s. Therefore, even though formal conservation-oriented legislation was minimal during this period, the continued narrow profit disconnect for lobstermen did reinforce the "conservation ethic" that started during the Great Depression (Acheson and Gardner 2011). This informal response conforms to the early conservation expectation derived from the AC/SC framework, though it should be noted that bioeconomic problem signals were relatively week until the late 1960s.

In contrast, there was more conflict in this period than would be expected from Figure 4. Of course, collective action remained in place, so conflicts over fishing grounds were minimal, but the economic divide between dealers and fishers led to significant conflict over prices. Since the entry of well-smacks in the 1800s, dealers had a certain amount of economic power over fishers. They provided much of the capital that fishers used to purchase new vessels and gear and many worked out informal agreements with fishers to ensure a steady supply (and guaranteed purchase price for the fisher). This dynamic increased drastically with the formation of the joint U.S.-Canadian North Atlantic Lobster Institute, a dealer consortium that formed during the war. By the 1950s, lobstermen started to organize to break dealer controls on prices, forming the Maine Lobstermen's Association (MLA) in 1954. Exceptionally low ex-vessel prices drove Maine lobstermen to tie up their boats in protest for a week in 1956 and this was just the start of a prolonged struggle for market control that included the development of fishers co-operatives to compete with dealers and a court case against MLA leaders, who were charged with price-fixing because they instigated the tie up. The court ruled against the MLA but penalties were minimal and the growth of five new lobster co-operatives helped to break dealer control over prices by the early 1970s (Acheson 1988, Formisano 1997).

Late 1960s through 1970s

Several changes in the lobster industry that started in the 1950s substantially altered the profit/power dynamics by the end of the 1960s. Shifts in market structure described above allowed ex-vessel prices to rise substantially. This trend was compounded by continued growth in demand for lobsters generally and the introduction of new technologies that helped to reduce costs of production. Thus, the profit disconnect increased rapidly in this period. At the same time increasing entry and diversification in the fishery eroded historical systems of access rights that had limited effort in the past (Acheson 1975). On the other hand, the distribution of power became more uniform because fishers were now well-organized politically and economically, even when compared to dealers. This places the fishery in the upper right box of Figure 4, where we expect prolonged conflict over access rights and delayed conservation measures.

In his famous work, Acheson (1988) describes the 1970s as a period of constant conflict over management. There was agreement that the stock was declining and that effort was much too high, both economically and biologically, but no agreement on which group of fishers should cut back. Lobstermen who worked year-round wanted to ban "part-timers" and recreational fishers, who of course defended their access rights. Thus, exclusion was hotly debated but the only actual steps taken prohibited entry by a new type of lobster fishing that was expanding rapidly in states south of Maine: "dragging" for lobster. This method was highly efficient for offshore production because the dragged gear could cover more ground in areas where lobster tended to be spread out. As such, it was also a major threat to the numerous small-scale lobstermen of Maine, who lobbied vociferously to keep the gear out of the state. They were successful in 1977 (Maine Revised Statutes [date unknown], Schreiber 2007). As noted above, exclusion of outside groups is an exception in the expectations for this category. On the other hand, the same legislation also created a licensing system for the lobster fishery. This was a case of vertical interaction, as a federal law, the Magnuson Act required improved licensing and data collection in all U.S. fisheries within the newly created 200-mile Exclusive Economic Zone.[3] Licenses were not limited so this is not a conservation-oriented regulation, though it did serve as a precursor for later legislation (NOAA 1983).

Although many were recommended, only one conservation-oriented law was passed in this period. In 1974, the legislature agreed to require escape vents to allow undersized lobster to exit traps. This bill was advertised as a cost-saving measure, because large numbers of undersized lobster were being caught and thrown back, taking considerable time and effort in what was still a labor intensive industry (Krous 1977). Adoption of such an expedient law that was supported by existing institutions is not surprising given the responsive governance paradigm. Scientists also recommended changes to the double gauge law to allow more female lobsters to reach reproductive age in the 1970s. They argued that this would negate the need for the V-notch law and would in fact protect more females of reproductive age (Lobster Research Project 1974). However, as Acheson and Gardner (2010) point out, fishers were extremely reluctant to accept changes to existing institutions, which they firmly believed were responsible for bioeconomic resurgence of the fishery after World War II. Certainly, these institutions had considerable staying power, and are still followed today, but the prolonged conflict and lack of a change in existing governance is also predicted by the AC/SC framework; there simply was not enough impetuous in the period to overcome conflict and agree on conservation measures because the power disconnect and the profit disconnect were both increasing.

1980s and 1990s

Yet again, exogenous changes altered the profit/power dynamic in the 1980s. Higher costs of production and increased competition from imported lobster drove profits down rapidly. The disappearance of lobster from near shore fisheries forced many "river" lobstermen to invest in larger vessels and move off shore. At the same time, closure of other fisheries in the region sent a surge of new entrants into the lobster fishery, substantially increasing competition and magnifying incentives for exclusion (Acheson 1988). Nevertheless, power was still distributed fairly evenly among groups and so the fishery moves from box 2 to box 1, and the expectation is for collective action to solve conflicts among fishers and relatively early conservation measures. In this case the predictive capacity of Figure 4 starts to break down, largely because these expectations were derived based on a simple CPR model and did not consider the effects of constant switching

between categories. In particular, the high level of overexploitation and increasing demands on the resource by new entrants greatly undermined collective action regimes rather than reinforcing them. The result was a period of conflict and stalemate similar to the expectations described in box 2 where the profit/power disconnects are wide and distribution of power is relatively uniform.

The conflict of the 1970s continued into the 1980s in spite of the narrowing profit disconnect. It is difficult to compare changes in the profit disconnect over time, but part of the problem may be that even though narrower than in the 1970s, it was still not nearly as devastating to the industry as the sudden drops in demand seen in previous periods of low profitability. Indeed, the presence of new entrants suggests that there was still some disconnect and the bioeconomic problem signals were only moderate, even if some long-time lobstermen left the industry because they did not like changes in the fishing culture (Acheson 1988). What is certain is that exclusion and control over access was very important in this period and that lobstermen believed that their pre-existing conservation practices should be sufficient if they could control entry and distribute the catch more evenly among remaining fishers. It is also important to note that the federal government played a more important role in this period. A lobster management plan for all of New England was proposed in the early 1980s. In included many regulations that were already enacted by the State of Maine but several key components were different, notably the higher minimum size limit described above, ending of the V-notch practice, and removal of the upper limit in the double gauge law (NOAA 1983, Acheson 1997). Although the MLA appeared to compromise on this law in 1986, accepting a higher minimum size with retention of the V-notch and maximum gauge, they almost immediately reversed their position on the minimum size, which was overturned the next year. For a short while at least, Maine fishers were the only lobstermen allowed to harvest smaller lobsters, which is in a way a form of exclusion, though whether this was the MLA's intention cannot be proved. The effective exclusion of their fishers certainly angered other states, and the federal government was not pleased by the rapid policy reversal, but ultimately the new size limit was abandoned in the New England management plan (Acheson 1997).

By the 1990s, the desire to exclude outsiders and limit effort was even higher than in the 1970s and 1980s, largely because bioeconomic problem signals like trap congestion, lower catch per effort (and related higher costs), and lower prices all escalated over the period. In 1994, the MLA introduced a comprehensive plan to limit effort in federal waters, including a moratorium on entry for two years, but they did not have sufficient influence with the Fisheries Management Council to push this through, particularly when other states were still growing their offshore lobster fleets. Within Maine, however, the constant lobbying over access rights finally culminated in the passage of a zonal management program that would give power to exclude back to local councils. The powers wielded by these bodies, elected by licensed lobstermen, not the public, included limits on the maximum number of traps, the number of traps per string, and time area closures of the fishery (Acheson 1997). Although trap limits might be seen as conservation measure, overcapitalization was exceptionally high in this period and reducing the number of traps was not expected to reduce harvests overall. Rather, the goal was to reduce costs and to place a cap on a small number of fishers who employed more than their "fair share" of traps. As early as 1979, it was clear that increasing the number of traps was simply reducing the number of lobsters per trap. Furthermore, although most fishers fished less than 500 traps, about 20% fished more, including about 10% fishing on 700-1000 traps. In addition, Canada had already implemented zonal trap limits quite successfully and this new program was seen as a way to increase competitiveness against a rising tide of Canadian imports (Lobster Research Program 1979).

Interestingly, the idea for this program did not come from the industry directly but was internally generated by the Marine Resources Committee of the Maine Legislature to reduce conflict among fishers that had lasted for many decades. However, with this change in the structural context, lobstermen did exercise their right to exclude, with most zones limiting the number of traps to 600-800 within a few years (Acheson and Gardner 2010). This supports the institutional perspective that collective action at the local level requires support from formal institutions at state or regional levels, although by this time most of the old "harbor gangs" of Maine were gone, except in the "down east" region (Ostrom 1990, Billings 2014). Nevertheless, we do see lobstermen clinging to existing conservation measures and working strenuously to exclude outsiders in this period. The structural context just did not favor collective action in its classic form. This suggests a need to amend the expectations for box 1 in Figure 4 to take better account of structural realities.

2000s to date

By the end of the 20th century, exogenous forces, notably the collapse of groundfish stocks like cod, allowed the sustainable level of lobster production to increase substantially (Zhang et al. 2012). However, the open access level of production and nominal prices for lobster also increased significantly.[4] As would be expected, a steep increase in landings without concomitant growth of demand led to declining real prices in the 2000s and, in spite of the relatively wide profit disconnect and relatively healthy stocks, lobstermen started to experience negative price signals in the 2000s (Schreiber 2013). One response to this signal was the development of community supported fishery programs to boost local demand and secure a stable revenue stream. Another was ratcheting up of exclusion under the existing Zone Management Law. Conflict among fishers over access increased again when the profit disconnect narrowed with the recession of 2008. Interestingly, capital-rich fishing interests chose to push for a removal of the ban on use of draggers to catch lobsters around this time. Offshore fishers in particular would like permission to use these more effective gears to take advantage of the higher stock size. This would, of course, further increase production and could dampen prices if demand does not rebound more rapidly but it could also start a reinforcing feedback loop, allowing offshore fleets to increase in profitability and political power and shifting the system back into box 4 of Figure 4, where all of the hard-won conservation ethic of the last century would be eaten away. In either case, this law would be crippling for inshore fishers using single-line traps and so far their opposition has prevented this change in legislation (Marine Resources Committee 2007, Schreiber 2007).

Meanwhile, ecologists warn fishers and decision makers alike that lobster is caught in a "gilded trap" created by heavy reliance on just a few species, and that the current wealth of lobsters could

easily be tipped across a threshold causing the stock, and the ecosystem, to collapse. These concerns are heightened by oceanographic shifts associated with climate change and there appears to be a clear need for precaution in the face of high uncertainty regarding future environmental conditions (Steneck et al. 2011). Nevertheless, catches continue to increase to record levels every year and fishers remain convinced that their age-old practices will sustain the stock and that managing effort, particularly through exclusion of outsiders and "equitable" distribution among insiders via trap and gear limits, is all that is needed to grapple with the ongoing crisis of demand. If the lobstermen are correct, then their future is secure, but if the scientists are right then continued responsive governance will lead to severe crisis in the near future. Ultimately, this is the case for all ecological problems that are not signaled by economic costs.

DISCUSSION

As a predictive tool, the power/profit dynamics that were derived from the AC/SC framework work fairly well. Expectations described in Figure 4 were met in almost all of the time periods covered in the lobster case. Some amendment of these expectations to include initial conditions and existing institutions is indicated, particularly by the divergence from the collective action expectation in the 1980s-1990s period. Expected exogenous and endogenous sources of transition between profit/power categories were also observed throughout the case study, though no attempt was made to predict specific sources of change in particular periods. Clearly, developing better data sets that allow for more rigorous comparison of the state of the profit disconnect and bioeconomic problem signals over time is also important because there does appear to be some difference in response between periods of extreme change in the profit disconnect and related signals, i.e., the Great Depression, and smaller, more gradual shifts observed in later periods. Nevertheless, accounting for both power and profit disconnects does provide considerable insight into the long history of management in this iconic fishery.

Perhaps most important, the case above explains both stability and change in the lobster fishery using a unified framework. It shows how changing incentives lead to bursts of management that have lasting effects even in periods when increasing profits and/or prolonged conflict prevent new action from taking place. It also highlights interactions between exclusionary response and conservation response, narrowing the gap between institutionalists like Acheson (1988, 1997) and political ecologists like Brewer and Brewer (2012) who point out the distributional effects of lobster governance. A third key contribution is the identification of long-term cycling of governance between the two cycles presented in Figure 1. Webster (2015) refers to this as the management treadmill. For over 200 years, governance of the lobster fishery shifted back and forth between effective and ineffective periods of management. Although the "conservation ethic" described by Acheson persisted throughout multiple cycles it did not prevent exogenous shifts that led to periods of increasing bioeconomic problems. Furthermore, the frequency of these shifts increased over time. With the exception of the Great Depression, early management periods lasted 3-4 decades but by the middle of the 20th century shifts occurred every 10-20 years. This escalation can be traced to exogenous growth in demand for lobster, which increasingly undermined governance institutions that were developed to minimize conflict among fishers and conserve the resource. This suggests that we may need to look beyond fisheries management to build sustainable fisheries.

Although the insights above are important, clearly more testing and refinement is needed for this approach. First, within the area of fisheries research, it is important to show that the profit/power dynamics described in Figure 4 are widely applicable in other fisheries where noncommercial and exogenous actors have little influence. It is also necessary to analyze the broader implications of the AC/SC framework described in Figure 3 by compiling additional case studies in fisheries where noncommercial and exogenous actors do wield political power. Systematic study of endogenous and exogenous factors that switch fisheries from one profit/power category to another would also be useful. Second, similar studies in other issues areas will help to establish the generalizability of the AC/SC framework and related expectations regarding profit/power dynamics and governance response. This may require additional theoretical work, particularly for areas where the common pool resource driver is absent. However, given that exogenous drivers like growing demand and globalization affect all resource industries, application to private property systems is clearly essential. Finally, in all new work it is important to find ways to quantify key variables, particularly the profit disconnect and bioeconomic problem signals so that more detailed comparisons can be made across time. This will be very difficult in fisheries because cost data are not often provided by fishers but it may be feasible in other areas.

CONCLUSION

The analysis above supports the AC/SC Framework as a useful approach to holistic understanding of fisheries management issues. In fact, the conclusions presented here are encapsulated in the logic of the framework itself. The framework shows that, while governance is problem driven, it may be heavily dependent on human perceptions of specific signals and their relative positions of power. This is what makes the profit and power disconnects such important predictors of response. In this, response can be facilitated by structural factors as described in much of the existing literature but it is also necessary to watch for those windows of opportunity created by changing incentives and power structures. Management response will be most adaptive when the action cycle aligns with favorable structural conditions, sending strong signals to powerful parties at times when the most expedient response is also perceived to be effective, shoring up governance over the long run. Response will be stagnant or ineffective when signals are dampened by structural factors, particularly economic changes that widen the profit disconnect or political dynamics that generate prolonged conflict.

Most important, the AC/SC framework predicts and the case study demonstrates that environmental governance is a chronic problem. Management and other informal governance institutions tend to cycle through effective and ineffective periods, with switching driven by both endogenous and exogenous factors. Over the last century, drivers of this cycle have been increasing and so the treadmill is speeding up. This does not just mean that problems arise more quickly but also that they tend to be more severe. In the lobster case, this pattern was mitigated over the last few decades because of an exogenous environmental shift that increased lobster productivity, but the opposite behavior has also been observed in many fisheries. As the management treadmill

speeds up, stocks are pushed closer and closer to ecological thresholds and bioeconomic collapse. The same is true in many other environmental issue areas and there is a clear argument here to at once accept the chronic nature of the governance problem and also look to the exogenous forces that drive the management treadmill.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/7272

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