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Commentary: Linking Movement Ecology with Wildlife Management and Conservation

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A commentary on

Linking Movement Ecology with Wildlife Management and Conservation
by Allen, A. M., and Singh, N. J. (2016). Front. Ecol. Evol. ***3****:155. doi: 10.3389/fevo.2015.00155*

Allen and Singh (2016) synthesize the ways movement ecology can inform wildlife management and conservation. The authors develop the "Movement Management Framework"—a stepwise decision tree for evaluating the types of data derived from animal movement studies and how that data can inform conservation decision-making. The authors provide a comprehensive review of the relevant literature but their decision-making framework ignores crucial aspects of modern decision science (Gregory et al., 2012). Here, we build on their framework by adapting it to better reflect current thinking around how movement information can be included in the decision-making process. Specifically, we highlight missing early steps in the planning stage related to prioritizing actions, questions to ask related to how movement data influences the selection of actions and other opportunities to refine plans through adaptive management.

First, we note that there is an important difference between the "broad goals" mentioned by Allen and Singh (2016) and "explicit quantitative objectives" (Tear et al., 2005). Without transforming broad goals into quantifiable objectives, decision makers run the risk of trying to solve an ill-defined problem, a common mistake of conservation prioritization (Game et al., 2013). For example, the goal of the author's Salmon case-study, whose populations are threatened by overfishing and hydro-electric dams, was "to reverse the decline of salmon stocks whilst maintaining activities like recreational and commercial fishing" (Allen and Singh, 2016). Quantifiable objectives that make this broad goal operational could be to: improve the passibility of rivers so that some average fraction, X%, of a population enters upstream spawning habitat; or have a 90% chance of maintaining or increasing current catch per unit effort for commercial fishers. Setting quantifiable objectives so that actions can be prioritized and evaluated in space and time is the essential first step after broad goals have been defined. These objectives will then dictate the choice of actions and performance metrics used to evaluate if the actions have been successful (**Figure 1**).

Next, we emphasize that identifying and choosing actions should occur at the onset of the planning process, not the "Implementation stage" as the author's suggest. Implementing a conservation plan is largely a social and political process where communicating and engaging with a broad audience of managers, policy-makers, and stakeholders is key. Implementation often does not succeed or fail based on ecological factors, but because divergent values and perceptions were not adequately recognized or considered in the selection of actions during the planning stage (Biggs et al., 2011).

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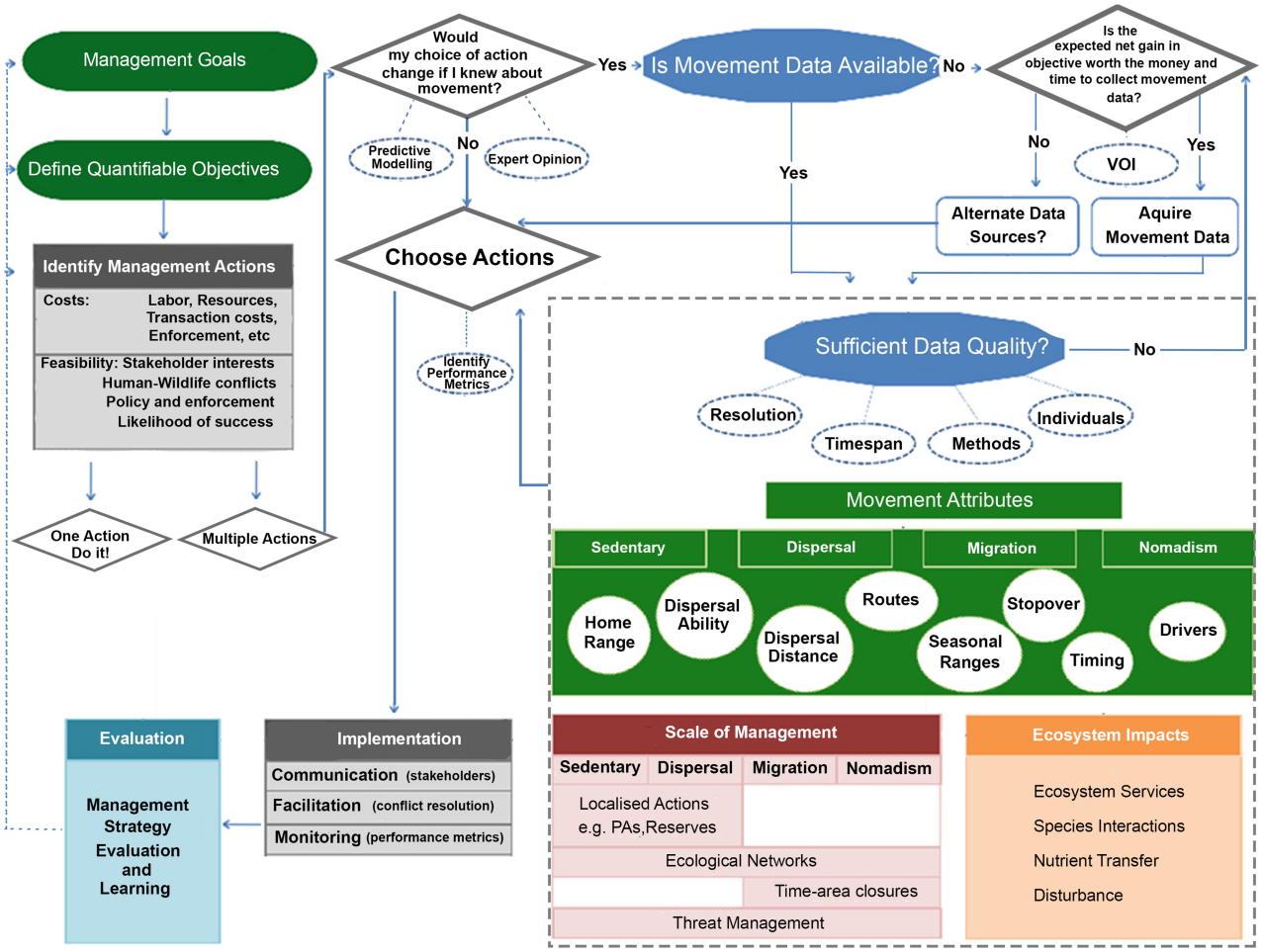

FIGURE 1 | The Movement Management framework, adapted from Allen and Singh (2016), provides a workflow for integrating movement ecology into conservation decision-making. Notable changes include steps to define quantifiable objectives, and identify and choose between management actions. Elements in and attached to diamonds are new additions to the workflow reflecting a focus of the value of information to inform decisions. Characteristics of movement data, such as quality, attributes, scale, and impacts aid the selection of actions in time and space.

Once we have a suite of quantifiable objectives we believe that managers and decision-makers need to list and screen possible actions. In some cases we may discover that only one action may be politically and economically feasible, in which case, managers may be better off just implementing it rather than waiting for more data to be collected. When multiple actions are possible, the author's are correct in stating the most cost-effective action or set of actions delivering the greatest benefit, or a predetermined outcome, should be prioritized. For Atlantic Salmon populations, actions could be to strategically place fish ladders, alter water flow regimes, physically transport individuals, and reduce fishing effort. Prioritizing between these actions requires information on the costs, feasibility (economic, social, and technical; **Figure 1**) and the likelihood the action will achieve its objective (Carwardine et al., 2008). If we quantify these attributes up front we can often rule out certain actions.

Uncertainty is common in management decisions and the information derived from movement studies helps reduce uncertainty about both the system being managed, and the impact of the actions on the system (McDonald-Madden et al., 2010). However, acquiring new data is costly and time consuming. In the context of informing decisions, investing in more animal movement data should be carefully considered in terms of its ability to change or alter a management action and deliver a substantial expected benefit, not merely to refine parameters, build better models or better understand how animals move (Runge et al., 2011). Value of information analysis can assist with this conservation conundrum as it rigorously examines the trade-off between the costs and expected benefits (measured in terms of outcomes) of gathering new data (Maxwell et al., 2014; Canessa et al., 2015).

Our **Figure 1** emphasizes that monitoring of performance metrics assists with evaluation, refining and learning during post-implementation stages. The author's suggest that evaluation may result in a redefinition of management goals in the long-term, but new information may also lead to iterative improvements in the near-term by refocusing objectives and/or defining new actions via adaptive management (Grantham et al., 2009).

We hope this is a constructive addition to the framework offered by Allen and Singh (2016). They correctly place telemetry data into an adaptive management framework, a significant advance, but fail to prosecute the case for the value of movement information in terms of outcomes.

AUTHOR CONTRIBUTIONS

All authors contributed to the idea development, content, and writing of this submission.

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