



Review

Applying behavioral theories to invasive animal management: Towards an integrated framework



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ABSTRACT

Invasive species wreak an estimated \$1.4 trillion in damages globally, each year. To have any hope of reducing this damage, best-practice control strategies must incorporate behavior change interventions. Traditional interventions, based on the *knowledge-transfer* model, assume that if land managers are properly educated about risks and strategies, they will develop supportive attitudes and implement appropriate control strategies. However, the social sciences have produced a large number of behavioral models and frameworks that demonstrate that knowledge transfer, by itself, fails to change behavior. The challenge then lies in knowing which behavioral model to choose, and when, from a potentially overwhelming 'universe'. In this paper, we review nine behavior theories relevant to invasive species management. We then introduce the *Behavior Change Wheel* as a tool for integrating these theories into a single practical framework. This framework links drivers of and barriers to behavior change with intervention strategies and policies, in what we consider, from an applied perspective, to be an important advance.

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1. Introduction

Invasive animal species significantly impact the environment, economy and society. Managing invasive species is an important global priority; estimated damages total more than \$1.4 trillion per year (Pimentel et al., 2001) and millions of dollars are spent annually on research and development of best-practice methods (Fitzgerald and Wilkinson, 2009; Gong et al., 2009). To ensure land managers adopt these new methods and integrate them into everyday practices, behavior change interventions are required.

Research into human behavior is extensive; a large number of social science models provide a deeper understanding of factors that promote and prevent behavior change. However, most of behavior change research related to invasive animal management has not explicitly linked to any specific behavioral theory.

Instead it has been widely and erroneously assumed that values and attitudes directly influence human behavior (Fitzgerald, 2009; Homer and Kahle, 1988). Thus, the focus of research, to varying

degrees, has been on the knowledge, values and attitudes of individuals towards invasive species and their impacts (Fitzgerald, 2009; Fitzgerald et al., 2007; Miller, 2003; Miller and McGee, 2001; Southwell et al., 2013). In this context, providing information has been at the forefront of invasive species management intervention strategies, the misplaced assumption being that if individuals are adequately informed they will develop supportive attitudes, and consequently modify their behavior (Burgess et al., 1998; Kollmuss and Agyeman, 2002).

Furthermore, behavioral models can help identify the most important drivers of behaviors, but they do not specify how to bring about behavioral change. For that we need to explicitly link drivers of behavior to interventions designed to change behavior.

To that end, many theories of change have improved our understanding of how change occurs, and helped identify leverage points to initiate and sustain change. Also, several frameworks for developing and evaluating behavior change interventions have been proposed (e.g., Darnton, 2008; Jackson, 2005; Michie et al., 2011). However, to date there has been no direct application of these frameworks in invasive animal management.

In this paper, we review nine behavior theories relevant to invasive species management. We group these theories into four

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broad and sometimes necessarily overlapping categories: (1) expectancy-value models, (2) models emphasizing normative influences, (3) models that incorporate effect, and (4) broader contextual models.

We then introduce the *Behavior Change Wheel* (Michie et al., 2011) as a tool for integrating these theories into a single practical framework for: (1) identifying and understanding the drivers of and barriers to land-managers adopting best-practices for invasive species management, and (2) linking these drivers and barriers to specific behavior change interventions and policies.

2. Behavioral theories

Decision making in invasive species management to date has relied heavily on the notion that rational choice assumptions underpin behavior. That is, individuals will always make prudent and logical decisions to act based on benefits and costs, and will select the behavior that is in their highest self-interest and maximizes their net welfare (e.g., Gong et al., 2009; Hone, 1994; Meurk, 2014).

Rational choice underpins a broad class of decision making theories known as expectancy-value (EV) theories – the first of our four broad categories. These theories are based on the idea that action is motivated by the expectations of the consequences of our behavior, and the values and probabilities attached to those outcomes (Darnton, 2008). Attitudes are then a result of the function between beliefs about behaviors and the value of outcomes arising from that behavior (Fishbein, 1963; Fishbein and Ajzen, 1974). Numerous behavioral theories have expanded on this basic attitude-behavior assumption by either adding other factors to improve the predictability of the model, or changing the combination and/or specificity of the determining factors. We review three EV theories in the following sections, highlighting applications to invasive species management.

2.1. Health belief model

The health-belief model (HBM) was developed in the 1950's to explain and predict health-related preventive behavior (Janz and Becker, 1984; Rosenstock, 1966, 1974). Based as it is on EV theory, HBM assumes that behavior is completely determined by anticipated outcomes. The constructs used in HBM are: (1) perceived susceptibility or risk of developing a problem, (2) perceived severity of the problem and its consequences (the combination of susceptibility and severity are often referred to as perceived threat), (3) perceived benefits of taking action, and (4) perceived barriers to taking action. HBM also hypothesizes that a cue or trigger is necessary for prompting engagement in the behavior. Such cues to action can be internal (e.g. pain, symptoms), or external (e.g. visual materials like brochures and posters, or verbal information from family or professionals). The notion of self-efficacy, an individual's perception of their competence to successfully perform a behavior (Bandura, 1977), was added later to HBM to improve the predictive power of the model (Rosenstock et al., 1988).

Although developed for preventive health behavior, the constructs behind HBM can easily be imagined as determining participation in invasive species management. If individuals perceive they are susceptible to negative impact from invasive species, if there is a severe negative outcome if they don't participate in management activities, if the benefits of participation are likely to reduce the negative impacts and/or the barriers to adopting the management activities are low, then they are more likely to adopt the required management activities. An individual's perception of their ability to successfully perform a management action, such as set a trap for an animal, would also influence their participation. Cues to action could include actual observations of

negative impacts (e.g. damaged crops or injured livestock), or information presented at field days or provided by government.

This model attempts to predict behavior by only accounting for individual differences in beliefs and attitudes, and as such it suffers from the similar limitations of rational choice theory in general. For example, HBM is unable to explicitly account for the influences of other factors, such as the impact of emotions, habitual behaviors, and social or environmental factors (Glanz et al., 2008; Janz and Becker, 1984; Rosenstock, 1966). It also does not specify how the constructs of the model interact with one another, making it difficult to define and evaluate (Carpenter, 2010; Glanz et al., 2008).

2.2. Protection motivation theory

The protection motivation theory (PMT) is another EV based-theory, and as is the case with the theory of planned behavior (section 2.3), a mediating intention variable exists between attitude and behavior: the protection motivation construct.

This theory was initially developed by Rogers (1975) in order to better understand fear appeals on attitude and how people cope, although it has now been expanded to include a broader range of information sources, and has become a more general theory of persuasive communication that could be applied to any situation involving threat (Maddux and Rogers, 1983; Rogers, 1983). It is based on the fundamental ideas of cognitive appraisal processes and how they relate to coping with stress (Lazarus and Folkman, 1984), and proposes that individuals protect themselves (protection motivation) based on the interactions between the threat appraisal process and the coping appraisal process.

Threat appraisal evaluates maladaptive behaviors (i.e. behaviors that are harmful), and is a function of the perceived severity of a threatening event, the perceived probability of the threatening event occurring (personal vulnerability), and any maladaptive response rewards (both intrinsic and extrinsic). The coping appraisal process evaluates the ability to cope with and avert the threatened danger, and is a function of the efficacy of the recommended response behavior, the perceived self-efficacy, and the response costs (Floyd et al., 2000; Milne et al., 2000; Rogers, 1983). These appraisal processes are initiated from two main sources of information; environmental (e.g. verbal persuasion, observational learning), or intrapersonal (e.g. personality variables, feedback from prior experience) (Rogers, 1975, 1983).

PMT has not explicitly been applied to invasive animal management, however persuasive communications, containing some form of threat message to the individual's livelihood, lifestyle, or the natural environment, are commonly used to increase participation in invasive animal management.

According to PMT, the decision to take protective action (i.e. conduct a management activity) becomes a positive function of the perceived severity of the invasive animals impact, and the feelings of vulnerability to this harm. These considerations must override the rewards of not conducting a management activity, and/or tolerating or actually increasing the prevalence of these animals for other purposes. This appraisal of threat supplies the motivation to initiate some form of positive management action. To decide to adopt the recommended management practices, a person must believe that performing this action will reduce the impact, and that they have the ability and will to perform the action. These considerations must outweigh the costs (e.g. monetary, time and effort, indirect effects on other animals) of performing the management activity.

PMT conventionally has been applied in the personal health contexts, where it has been shown to be a viable model on which to base individual and community health intentions (Floyd et al., 2000; Milne et al., 2000), and has provided an understanding of

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