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"Nature's Little Helpers": A benefits approach to voluntary cultivation of hatchery fish to support wild Atlantic salmon (*Salmo salar*) populations in Norway, Wales, and Germany

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ABSTRACT

Voluntary hatcheries, or hatcheries operated privately by local anglers and fishery owners, are a historical part of salmonid conservation and enhancement efforts in Europe. However, these types of hatcheries have faced increasing scrutiny over the last several decades because of the potential negative ecological impacts created by stocking salmon into wild (albeit declining) populations. We hypothesized that hatchery programs provide value to communities well beyond the possible conservation contribution to local salmon. Utilizing a qualitative ethnographic approach, we identified and classified a range of benefits produced by voluntary salmon hatcheries within three case studies in Norway, Wales, and Germany. Across all cases, voluntary hatcheries facilitated or provided diverse social, psychological, and conservation benefits to individuals and groups of cultivators, as well as to the river environment. Voluntary hatcheries can be considered as a visible means of environmental stewardship and are perceived by many operators as an important means for mitigating human obstacles to wild salmon conservation. Based on the multiple benefits that voluntary hatcheries create for the people engaged in hatchery activities, we lay out alternative views that add to the traditionally black-and-white, pro or anti-hatchery perspectives. Improved incorporation of multiple social-psychological hatchery benefits into future fisheries management decisions, outreach, and communication will provide a more holistic approach to sustainable hatchery management, reduce stakeholder conflict, foster civil engagement in salmon conservation, and enhance environmental stewardship.

1. Introduction

Stocking is a much used and abused management tool in fisheries management and conservation world-wide (Cowx, 1994). Stocking objectives range from improving fishing opportunities to purely conservation-oriented stocking activities designed to protect and enhance small or declining populations (Arlinghaus et al., 2016; Lorenzen et al., 2012). Though stocking of salmonids (*Salmonidae*) has historically been a widespread, popular management initiative among many stakeholder groups to improve ("cultivate") wild stocks (Berg, 1986; Bottom, 1997; Wolter, 2015), improvements in scientific understanding of potential negative impacts of cultivation on wild salmonid populations (Bolstad et al., 2017; Glover et al., 2017) have challenged the scientific and managerial opinion in relation to stocking (Arlinghaus et al., 2015; Lorenzen et al., 2012; Sandström, 2011). Stocking can produce significant benefits to fisheries and help restore and conserve fish populations (Lorenzen et al., 2012). Although a range of contextual factors affect the outlook of stocking programs, in many situations alternative tools to stocking may prove superior in protecting and enhancing threatened fish stocks (Arlinghaus et al., 2016). However, stocking where hatchery fish are released into naturally recruiting populations can produce significant conservation concerns. Stocking has been documented to spread disease (Hewlett et al., 2009), affect local genetic integrity through population mixing (Laikre et al., 2010), reduce population growth of wild stocks (Chilcote et al., 2011), and contribute to the challenges faced by the wild stock component in anthropogenically altered rivers (Buoro et al., 2016; Laikre et al., 2010; Lorenzen et al., 2012).

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Over the past 30–40 years, science has become increasingly critical toward stocking in light of unavoidable trade-offs between yield increase, cost, and potential negative impacts on wild stocks (Amoroso et al., 2017; Camp et al., 2017). As a result, in places where wild salmon populations still exist, stocking programs are increasingly being restricted (e.g., Norway) or ended (e.g., Wales) in a managerial preference to strengthen wild stocks through habitat restoration initiatives. Meanwhile, in places where salmon have gone extinct (e.g., Germany) or where populations have greatly declined (e.g., France), there is little alternative to stocking when trying to re-establish self-sustaining stocks in the wild (Granek et al., 2008). The same is true for rivers where the local salmon population has been significantly affected by parasite infection or environmental destruction (Forseth et al., 2017). In Germany, for instance, despite decades of salmon stocking no single self-sustaining salmon stock is known to the authors, suggesting that habitat limitations continue to constrain re-establishment of a stock.

Stocking governance systems differ throughout the world. In some countries such as the USA and Canada, stocking is typically conducted by state-run hatcheries. Conversely, in much of Europe fishing rights are private and tied to land ownership; here stocking decision-making is often conducted by local-level clubs and associations or by land owners (henceforth "cultivators") (Fujitani et al., 2017; Riepe et al., 2017; Stensland, 2010). In the European context, it has been commonly observed that private actors organize voluntary hatcheries designed to support, protect, and restore wild stocks of iconic, high-demand species such as Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*) (Arlinghaus et al., 2015; Daedlow et al., 2011; Fujitani et al., 2017), and that these initiatives remain popular amongst cultivator groups (Riepe et al., 2017). This study focuses on what we term "voluntary hatcheries", or hatcheries operated by local angling or river owner groups for the purpose of conserving local wild Atlantic salmon stocks through stocking either in stock rebuilding or stock enhancement contexts.

Hatcheries and associated stocking programs raise three primary concerns: 1) the physiology, behavior, and overall fitness of hatchery-reared fish and how they differ from wild conspecifics (Blanchet et al., 2008; Fleming and Petersson, 2001; Jonsson and Jonsson, 2006; Swain and Riddell, 1990); 2) the effect of stocked fish on wild stock genetics through inbreeding and disease and parasite transmission (Garcia de Leaniz et al., 2007; Verspoor, 1988); and 3) a preference among many stakeholders (i.e., anglers, river owners, and local managers) for hatcheries, sometimes used as a substitute for the lack of opportunity for large-scale river rehabilitation (Arlinghaus et al., 2015; Dabrowska et al., 2014; Stensland, 2012). Salmon cultivation opponents argue that hatcheries provide a false "easy fix" to more insidious problems affecting salmon stocks, effectively detracting funding and interest from long-term conservation work (Waples, 1999). From an economic standpoint, hatchery and stocking critics also argue that stocked salmon have generally low return rates in comparison to wild cohorts (Milot et al., 2013; Romakkaniemi, 2008; Saltveit, 2006) while requiring high annual investments. Stocking advocates, meanwhile, argue that stocking programs may accelerate a population's recovery when used in tandem with habitat improvement work, and that stocking can create additive effects to increase catch in some situations (Amoroso et al., 2017). Similarly, in cases where a population verges on extinction, there is arguably no alternative to stocking due to lack of a wild stock that could produce sustainable recruits (Arlinghaus et al., 2015).

Many organizations and stakeholders are involved in the stocking controversy at multiple scales of organization, including local stakeholders, regional and state agencies, and scientific and international organizations (Sandström, 2010,2011). International policies are often bluntly critical of salmonid stocking; for example, the intergovernmental North Atlantic Salmon Conservation Organization's (NASCO) Williamsburg Resolution "is designed to minimise impacts of aquaculture, introductions, transfers and transgenics on the wild stocks" (North Atlantic Salmon Conservation Organisation, 2006). In doing so, the resolution provides guidelines to stocking, which give direct attention to the negative impact of stocking on the genetic integrity of wild stocks (North Atlantic Salmon Conservation Organisation, 2006, pg. 16–17). These and other conservation guidelines (e.g., UN Convention on Conservation of Biological Diversity North Atlantic Salmon Conservation Organisation, 2017) direct national-level fisheries managers and policy makers to develop more restrictive guidelines for country-specific stocking programs (Sandström, 2011). Meanwhile, local-level hatchery supporters try to engage in the debate by citing hatchery-supportive literature and arguments, questioning the credibility of work that showcases negative impacts of stocking, and often referencing the specific circumstances of local hatchery and stocking projects (or related problems such as escapees from aquaculture) (Brannon et al., 2004; Siemens et al., 2008). Somewhat in the middle, Waples (1999) argues that hatcheries are neither inherently good nor inherently bad, and "neither of these positions leads to productive dialogue, nor is either supported by a thoughtful consideration of the issue" (pg. 13). Yet, managers are often compelled to rely upon "best available science" (Charnley et al., 2017) in designing cultivation policies. Such science typically is ecology and biology-oriented, omitting the human dimensions (Arlinghaus et al., 2017; Ditton, 2004). This is unfortunate, as human dimensions are usually of prime importance in fisheries management success (Arlinghaus, 2006). Attention (from both managers and local stakeholders) focusing on the non-human dimensions of fisheries management (Ditton, 2004) runs the risk of ignoring important causes and drivers of conflict (Arlinghaus, 2005; Arlinghaus et al., 2017, p. 201), in cases of voluntary hatcheries and stocking in general (Riepe et al., 2017; van Poorten et al., 2011).

While the debate over hatcheries focuses primarily on the effectiveness and risks of stocking, alternative roles and benefits of stocking and hatcheries, such as the psychological and educational benefits of being involved in conservation, remain largely unexamined. In this context, voluntary cultivation of salmonids shares many similarities with outdoor recreation. Such activities are self-chosen, voluntary, and based on the individual's investment of resources such as free time, money, and knowledge/skills. A large body of literature in outdoor recreation in general, and recreational fishing in particular, has underscored that participants engaging in angling activities reap multiple types of benefits (Driver and Knopf, 1976; Fedler and Ditton, 1994; Holland and Ditton, 1992; Parkkila et al., 2010; Weithmann, 1999). These benefits enable people to meet their needs, pursue their goals, and increase their quality of life; in other words, to increase their well-being (Britton and Coulthard, 2013; Pretty et al., 2007).

The psychological, physiological, social, and economic benefits that accrue on the level of the individual also interact across scales leading to effects on society on a larger scale (social/cultural, economic, and ecological) (Driver, 2009; Manning, 1999; Parkkila et al., 2010). For example, engaging in cultivation can foster the subjective/cognitive and relational well-being of the individual while also achieving instrumental conservation benefits (by increasing or conserving salmon stocks) that benefit communities or entire human-ecological systems (Voyer et al., 2017). If participants in voluntary cultivation of salmon derive multiple benefits from the activity, the resulting individual and societal benefits potentially exceed the costs of fish cultivation and its assumed physical contribution to salmon conservation.

We posit that voluntary hatcheries produce multiple benefits at both individual and group levels that exceed the "narrow" focus on the biological contribution of hatcheries to wild salmon populations. By drawing on the multiple benefits framework from outdoor recreation research (Driver, 2009; Manning, 1999), the objective of this study is to identify and assess the full range of benefits produced by voluntary hatcheries. We then use this assessment to understand the influence of these multiple benefits on salmon management, conservation, and conflict.