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# Updating the manager's toolbox: Mapping spatio-temporal trends in freshwater fishing

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ABSTRACT

Wildlife-associated recreation is culturally and economically important, yet relative participation in the United States is declining. To address concerns of recreation managers, we present an innovative way to assess temporal trends and the spatial distribution of licensees in conjunction with demographic, economic, biophysical and social datasets. Geocoding license-based wildlife-associated recreation (i.e., fishing and hunting) provides a cost-effective strategy for monitoring spatio-temporal changes and learning about a community. We demonstrate this approach by calculating the retention, recruitment and loss of licensed freshwater recreational anglers in North Carolina between 2008 and 2010, and examining the demographic profile of areas with the greatest loss of anglers from 2008 to 2010. We describe how geocoding licenses can help assess the sustainability of a recreational fishery and the quality of fishing resources. Tracking trends in license purchases can provide recreation managers with insight to make informed decisions in recruitment strategies, and avert overuse or overcrowding.

## MANAGEMENT IMPLICATIONS

- Geocoding of license information provides a cost-effective, widely-available technology to monitor spatial and temporal changes of licensed wildlife-associated recreationists.
- Changes in the spatial distribution of licensed anglers through time can provide insight into where recruitment and retention (e.g., outreach and advertising) are most needed.
- Joining license data to biophysical, demographic and socioeconomic data in a spatial context can provide managers stronger information for strategic planning and investment



## 1. Introduction

Wildlife-associated recreation is an important source of income for local and national economies (Munn, Hussain, Spurlock, & Henderson, 2010) and an important cultural ecosystem service that provides people an opportunity to interact with nature (Hernández-Morcillo, Plieninger, & Bieling, 2013). Despite the social and economic importance of these activities, research suggests that participation in the United States (US) is declining (USFWS, 2007), from 57% in 1991 (USFWS, 1993a) to 38% in 2011 (USFWS, 2013a). Furthermore, urbanites are less likely to engage in wildlife-associated recreation than their rural counterparts (Dempson, Robertson, Cochrane, O'Connell, & Porter, 2012; Schroeder, Fulton, Nemeth, Sigurdson, & Walsh, 2008). The decrease in wildlife-associated recreation may further a detachment between people and nature, decrease license sales, and thereby decrease state funds for conservation and management (ASA & AFWA, 2007; Mahasuweerachai, Boyer, Balsman, & Shoup, 2010). An assessment of wildlife-associated recreation provides valuable information to help understand how current and future trends in participation impact society, the economy, and the environment (Lewin, Arlinghaus, & Mehner, 2006). Being able to monitor such changes is important in order to maintain wildlife-associated recreation at a level that is both economically and environmentally sustainable (Pröbstl & Haider, 2013).

To date, monitoring and assessing wildlife-associated recreation has primarily been conducted through surveys at various

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spatial scales. The most comprehensive assessment of wildlife based recreation in the US is the Survey of Fishing, Hunting and Wildlife-Associated Recreation conducted by the US Fish and Wildlife Service (USFWS) every 5 years since 1991 (USFWS, 2013a). The state and national-level information published in the reports is widely used by federal, state, and private organizations to monitor trends, understand behavior and preferences of wildlife-associated recreation participants, and subsequently to manage activities (Tseng, Huang, & Ditton, 2012; USFWS, 2013a). Surveys can provide a wealth of information; however, it can be difficult to obtain a sufficient number of responses upon which decisions can be made (Graefe, Mowen, Covelli, & Trauntvein, 2011). Surveys also take considerable time to construct, disseminate, organize responses, and analyze (Sexton, Miller, & Dietsch, 2011). National or state-level data, like those gathered by the USFWS, serve to monitor social and economic dimensions of wildlife-associated recreation, but are sometimes insufficient to answer specific, place-based management questions.

## 2. Alternative management tools: geocoding licensed wildlife recreationists

A cost-effective supplement and/or alternative to recreation surveys is using Geographic Information Systems (GIS) to map the home location of licensed wildlife recreationists by means of geocoding. Geocoding consists of assigning longitude and latitude coordinates to the address of licensed wildlife recreationists. The increased accessibility and use of GIS coupled with greater electronic documentation by government agencies make geocoding the residence of license-holders a method that can provide novel, fine and coarse information regarding the geographic and temporal distribution of licensed wildlife recreationists. The geocoded licenses can be summarized by watershed, town, zip-code, county, or any geographic boundary that meets the objective of the analysis. Geocoding has been widely used to monitor the relationships between disease and socio-economic conditions (Krieger & Zierler, 2001) and to monitor rates and patterns of crime (Kuo, Lord, & Walden, 2013), but it has only recently gained importance in the fields of outdoor recreation and ecosystem services (Dabrowska, Haider, & Hunt, 2014; Villamagna, Mogollón, & Angermeier, 2014). Geocoded licenses can help monitor license-based wildlife-associated recreation patterns over time and space when coupled with demographic, social, and biophysical information (Table 1).

### 2.1. The case of freshwater recreational fishing

Herein, we describe the type of insight that can be gained from geocoding wildlife recreation licenses with the case of freshwater recreational fishing. Coupling geocoded fishing licenses with outside data provided by state fish and wildlife agencies, the US Census, and others, can help answer a variety of questions germane to the management of a recreational fishery (Table 1). Given the assumption that licensed anglers are more likely to fish near their homes (Hunt & Hutt, 2010), the density of anglers can be used as a proxy of ecological pressure (Villamagna et al., 2014). When coupled with social (e.g., access, amenities, and managed land) and biophysical attributes (e.g., quality of natural resources) that contribute to the capacity to support recreational fishing, the spatial and temporal distribution of licenses can provide insight on the sustainability of a recreational fishery (Table 1 and see Villamagna et al., 2014). Similarly, angler license sales have been shown to be a function of the quality of fishing resources and socio-demographic information, where findings suggest that participation can be enhanced by catch (e.g., stocking) and non-catch (e.g., accessibility, environmental conditions) efforts (Dabrowska et al., 2014).

Geocoded license data can also be paired with demographic data, such as the US Census, to answer more specific management questions, including but not limited to (i) how does angler density vary across the landscape? and (ii) how does the economic, racial, ethnic, and educational composition of high angler density areas compare to areas with low angler density? Along these lines, consulting groups, such as Southwick Associates, have helped state

**Table 1**
Potential demographic, social, biophysical and sustainability questions that can be conducted in conjunction with geocoded angler licenses.

| Category | Potential Questions | Data | Sources |
|---|---|---|---|
| Demographic | How does median community income relate to the density of anglers?<br>What is the dominant age group and racial profile of anglers within a new area targeted for recruitment?<br>Where should public hearings be held to maximize angler attendance?<br>Who should be invited to focal group meetings? | Income, race, ethnicity, education, sex, age, urban–rural, house-hold characteristics | US Census; ESRI's TAPESTRY® database |
| Social | Where should gear and bait shop advertisement be located to reach the greatest number of anglers?<br>How accessible are public fishing spots to licensed anglers?<br>Where are fish being stocked in relation to angler density? | Boating sites, stocking, bait and gear shops | State Fish and Wildlife Agency; State Conservation and Recreation Agency |
| Bio-Physical | What is the condition of land cover surrounding prime fishing spots?<br>Where should habitat restoration efforts be developed?<br>How does angler density relate to water quality or fish population/community metrics? | Waterbodies, impaired waters, land cover, fish abundance, fishing spots | State Environmental Quality Agency; USGS – NLCD and NHD; State Fish and Wildlife Agency |
| Sustainability | How does local angler density relate to overuse pressure and ecosystem degradation?<br>What is the relationship between local fishing conditions and license sales or angler retention? | GIS and statistical analyses | |

*Note*: Acronyms refer to: United States (US), Environmental Systems Research Institute (ESRI), United States Geological Survey (USGS), National Land Cover Database (NLCD), and National Hydrography Dataset (NHD).