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Short communication

## Using posts to an online social network to assess fishing effort

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### ABSTRACT

Fisheries management has evolved from reservoir to watershed management, creating a need to simultaneously gather information within and across interacting reservoirs. However, costs to gather information on the fishing effort on multiple reservoirs using traditional creel methodology are often prohibitive. Angler posts about reservoirs online provide a unique medium to test hypotheses on the distribution of fishing pressure. We show that the activity on an online fishing social network is related to fishing effort and can be used to facilitate management goals. We searched the Nebraska Fish and Game Association Fishing Forum for all references from April 2009 to December 2010 to 19 reservoirs that comprise the Salt Valley regional fishery in southeastern Nebraska. The number of posts was positively related to monthly fishing effort on a regional scale, with individual reservoirs having the most annual posts also having the most annual fishing effort. Furthermore, this relationship held temporally. Online fishing social networks provide the potential to assess effort on larger spatial scales than currently feasible.

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### 1. Introduction

Fisheries management has evolved from individual-reservoir to watershed-scale management (Carpenter and Brock, 2004; Martin and Pope, 2011) creating a need (Pollock et al., 1994) to simultaneously gather information within and across interacting reservoirs. Traditional creel surveys are difficult to implement on multiple individual reservoirs within a region because they are expensive and logistically difficult to conduct (Lester et al., 2003; Chizinski et al., 2014). Furthermore, among-reservoir variation in amenities, fish communities, and other recreational opportunities complicates the expansion of results from a subset of single reservoirs to all reservoirs in a region.

There is a need to develop a method to assess fishing effort across multiple reservoirs that is both cost-effective and easy to implement. Possible methods to collect effort-only data on a regional, or larger, scale include mail, telephone, and Internet surveys (Brown, 1991; Weithman, 1991), aerial surveys (Volstad et al., 2006), and bus-route count surveys (Jones and Robson, 1991). Although information on catch or harvest is often not collected during these

surveys, effort is often correlated to the harvest of fish (Michaletz and Stanovick, 2005). Mail and telephone surveys allow data to be gathered efficiently across multiple reservoirs, but these surveys can be subject to recall bias (Osborn and Matlock, 2010) and operate on a time-scale that is too coarse to detect short-term changes in regional fishing pressure.

Angler-related online social networks (e.g., Nebraska Fish and Game Association, [www.nefga.org](http://www.nefga.org)) create a community among anglers within a region, and often lead to the development of friendships and fishing partners outside of the online world (Ridings and Gefen, 2004; Tang, 2010). The use of these fishing forums has grown during the past decade and patterns of Internet search volume for terms such as “fishing forums” and “fishing” mimic seasonal trends observed in fishing participation (Martin et al., 2012). Anglers use these social networks as a way of relaying fishing conditions, often discussing where to go fishing and relaying stories of past catches.

Angler posts about reservoirs to online social networks provide a unique medium to test hypotheses on the temporal and spatial distribution of fishing pressure. We predicted that posts to an online social network would be correlated to estimated fishing effort temporally and spatially (i.e., across reservoirs and through time on a regional level). These posts provide an account of users' interest in recreational opportunities and are perhaps related to effort exhibited at a lake. Within the Salt Valley regional fishery in southeastern

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Nebraska, we examined the association between the number of posts to a fishing forum mentioning a reservoir and the observed fishing effort at that reservoir.

## 2. Methods

### 2.1. Study site

The Salt Valley watershed in southeastern Nebraska, USA includes 19 flood-control reservoirs that range in size from 5 to 730 hectares. The recreational catch in these reservoirs is dominated by largemouth bass *Micropterus salmoides*, channel catfish *Ictalurus punctatus*, bluegill *Lepomis macrochirus*, black crappie *Pomoxis nigromaculatus* and white crappie *Pomoxis annularis*. Wall-eye *Sander vitreus* and rainbow trout *Oncorhynchus mykiss* are caught seasonally. Annual angling pressure on these reservoirs during 2010 ranged from 61 to 3931 h/ha.

### 2.2. Online social network data

Data on posts to the online social network were gathered from the Nebraska Fish and Game Association (NEFGA) Forum. The NEFGA forum had 4964 members and 264,214 fishing-related posts as of January 28, 2013. On April 1, 2011, we searched all posts from April to September (period of greatest fishing effort) during 2009 and 2010 to the NEFGA fishing forum for all references to each of the 19 reservoirs.

### 2.3. Angler effort data

Data on angler effort were collected using a bus-route roving count at all 19 reservoirs during 2009 and 2010. Survey days and times were chosen following a stratified multi-stage probability-sampling regime (Malvestuto, 1996). Days were stratified by day-type with two strata: weekday and weekend days (all weekend days plus federal holidays). Each day was further stratified into three, 8-h shifts (00:00–08:00 [early], 08:00–16:00 [mid], and 16:00–24:00 [late]) per day. Two samples from each of the 6 day-type-period strata were randomly selected each month (i.e., two weekday-early, two weekend-early, etc.) for a total of 12 samples per month. Direction, start reservoir, and start time (within the first 2 h of period) were randomly selected for each sample period. Creel clerks were instructed to complete the loop around all 19 reservoirs as quickly as possible to ensure comparable numbers of anglers across reservoirs. Monthly estimates of effort and associated variance were calculated using equations provided by Malvestuto et al. (1978).

### 2.4. Data analysis

Analyses were conducted in R v2.15.2 (R Development Core Team, 2012) and used a significance level of 0.05. The relationship between effort and number of posts across reservoirs was assessed with Pearson's correlation that utilized a bootstrapping approach to account for temporal autocorrelation in posts. Reservoirs were treated as independent observations and for each iteration of the bootstrap, one observation of the 12 observations available (6 months  $\times$  2 years) for each reservoir was selected and the correlation coefficient was calculated between effort and post values. This was repeated for 1000 iterations to estimate variance in the correlations between monthly effort and monthly posts among reservoirs. A second Pearson's correlation was used to examine the relationship between effort and the number of posts to the online forum on a regional scale. Months were treated as independent observations and a monthly regional effort was calculated as the sum of

effort across all reservoirs within a month. The correlation coefficient was calculated between this measure of regional effort and a similar measure of regional posts calculated as the sum of posts made across the region within a month.

## 3. Results

The total number of posts to the NEFGA forum for the 19 reservoirs in the Salt Valley regional fishery was 1234 between April and September during 2009 and 2010, which accounted for 73% of the total posts during this period. The mean  $\pm$  SE number of posts per month about an individual reservoir ranged from  $0.2 \pm 0.1$  to  $23.0 \pm 3.4$  posts. The two reservoirs with the greatest number of posts were Holmes Lake, the largest urban reservoir in the region, and Branched Oak Reservoir, the largest reservoir in the region. Smaller reservoirs (surface area range 4–40 ha), with the exception of Bowling Lake, in the region had few posts except following events such as a large fish being caught and reported.

The total angler effort based on the bus-roving count between April and September at the 19 reservoirs in the Salt Valley regional fishery was 455,077 and 355,144 h during 2009 and 2010, respectively. The mean  $\pm$  SE angler effort per month ranged from  $258 \pm 87$  to  $14,207 \pm 2684$  h. The reservoir with the greatest angler effort was Holmes Lake. Small reservoirs (<40 ha), with the exception of Bowling Lake, had little angling effort.

The association between posts and effort was strong among reservoirs (Fig. 1). The median correlation coefficient across all 1000 iterations was 0.91 with a 95% confidence interval of 0.75–0.98. The association between regional posts and regional effort across months was also strong ( $r = 0.75$ ,  $p = 0.005$ ; Fig. 2).

## 4. Discussion

The NEFGA forum is used by anglers within the Salt Valley region of Nebraska to gather and exchange information on fishing resources within the region. Angler participation in the NEFGA forum provided an opportunity to use this online social network to test the association between angling effort and posts to the online social network on a regional scale. Anglers' posts about individual reservoirs vary from general questions about where to fish, reporting of fishing conditions, and reporting of extreme catches, either of large fish, multiple fish, or no fish. This sharing of information in an online format leads to faster and more complete sharing across the angling community than was previously available given only word-of-mouth transfer of information (Hampton and Wellman, 2003).

The number of posts to the NEFGA forum was related to the amount of angler effort on a regional scale. This indicates that the information gained from the online forum can be used as a relative index of angler effort across the region. Reservoirs, and months, that received the most angler effort also received the greatest number of posts. This method provided a quick and easy way to index effort across the reservoirs in this region by searching the online social network and calculating a monthly number of posts per reservoirs. This allows managers to look across an entire regional fishery and determine where anglers are spending their effort.

This method provides a simple way to gather angler effort data with minimal effort and expense. Effort data are often the most difficult and time-consuming type of data to collect on a social-ecological system. A traditional creel survey requires 120 h of work to gather effort through on-site counts (2, 1-h counts per sample day, 10 sample days per month, 6 months per year) whereas searching online forums for posts to gather an index of effort requires approximately 8 h of work. Furthermore, once searching for information on these online forums, the additional

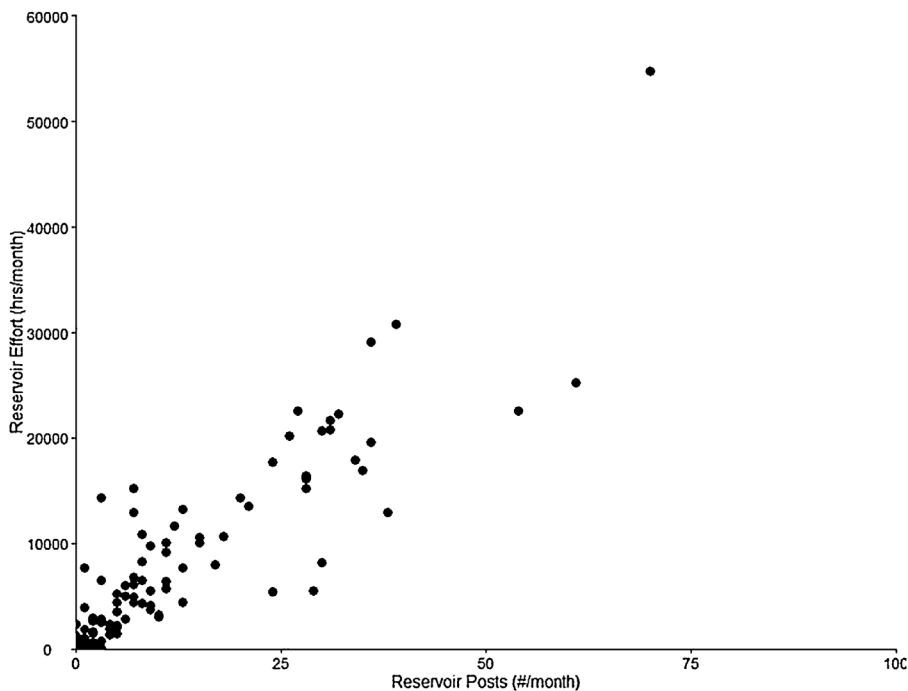


Fig. 1. Association between monthly number of posts to the online social network and monthly effort for the 19 reservoirs in the Salt Valley region of Nebraska during April–September 2009 and 2010. Median correlation after 1000 bootstrapped iterations ( $r = 0.90, p < 0.001$ ).

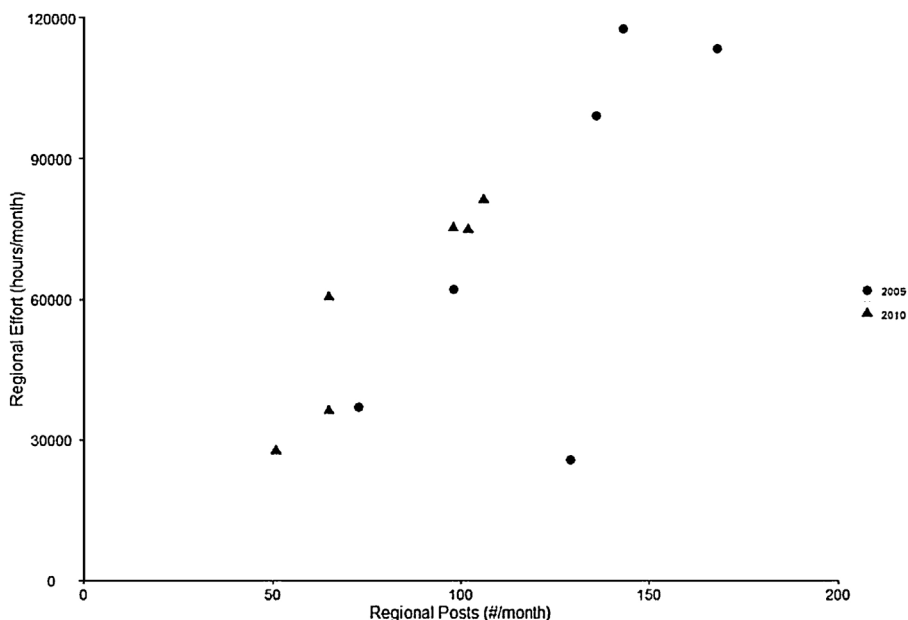


Fig. 2. Association between regional fishing effort and regional posts to the online social network for the 19 reservoirs in the Salt Valley region of Nebraska during April–September 2009 (black circles) and 2010 (black triangles;  $r = 0.75, p = 0.005$ ).

time required to gather information on multiple reservoirs is minimal.

Assessing effort at a larger spatial scale, regional rather than individual reservoir, is important for understanding how reservoirs interact with each other and how anglers perceive the whole set of reservoirs as a regional fishery. Additionally, other information of interest for managers could be gleaned from these forums as well. For example, information on what species anglers are targeting, violations observed by anglers, and anglers’ general perceptions of reservoirs amenities, fish communities, and access is available within these forum posts. The greatest potential influence on

management comes from the ability to monitor, in near real-time, changes in fisheries that are not usually visible until creel or standardized-fish sampling is completed.

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