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The economic contribution of instream flows to the lower Connecticut River Watershed, New England, USA

Abstract

River recreation is a rapidly expanding source of economic productivity. Angler spending has been used as the basis for estimating the regional economic estimates of local income and jobs in several water-limited systems of the western United States and Mexico. However, the contribution of outdoor recreation to the economies of regions that do not experience water scarcity continues to be underappreciated. This paper estimates the economic contribution of angling to the lower Connecticut River Watershed (CRW) economy. The authors draw upon existing angler expenditure, river flow and geographic information system (GIS) data to relate anger use of the lower CRW and expenditures to river flows. The authors then translate angler expenditures into state income and employment using a regional economic multiplier. The results show that fishing expenditures of $62.8 million per year equate to $74.2 million annually in supply chain revenues which supports 1660 jobs. The authors identified a significant positive relationship between fishing intensity and river flow rates, which suggests that decreasing current water diversions on the lower CRW by just 25% would add an additional $37 million and 638 jobs to Connecticut's economy. The findings demonstrate that investments in managing the health the CRW through flow restoration can have large economic and ecological pay-offs.

Keywords: instream flows, natural resource economics, recreation economy, river management, fishing expenditures.
JEL Classification: Q25.

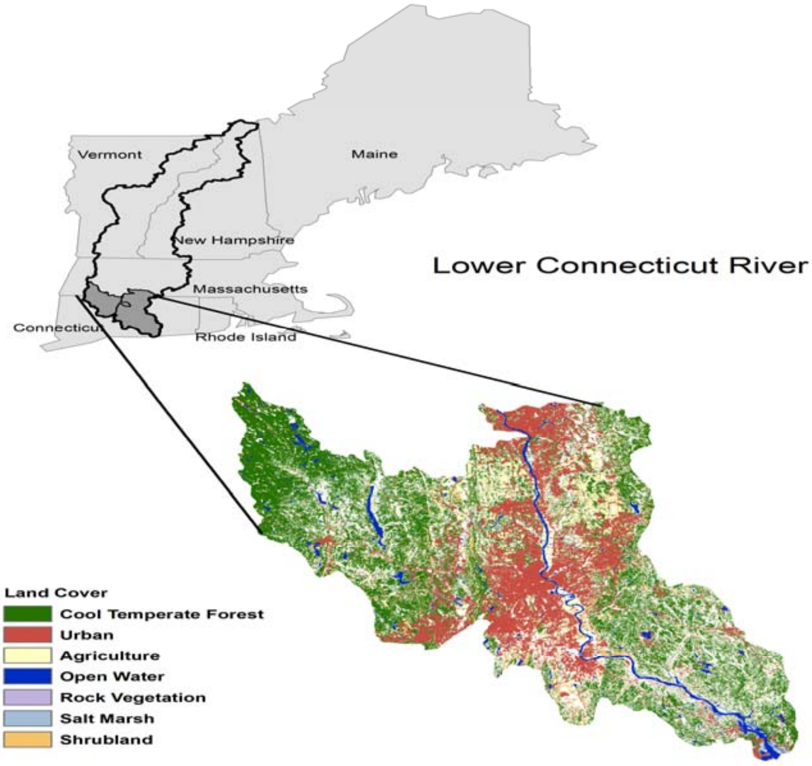
Introduction

Water has been recognized as an important economic commodity for millennia. The market value of water as defined by agriculture, energy, public water supply, and manufacturing often compete with 'non-market' and 'nonuse' values, or instream flows (i.e. undiverted water). Instream flows represent a sector of river productivity that is recently receiving attention as a major economic contributor to local and regional economies (Brauman et al., 2007; Hickey & Diaz, 1999; Loomis, 1998; Ward et al., 1996; Ojeda et al., 2008). Instream water uses are many and varied including recreation, aesthetics, hydroelectric power, and riparian habitat to name a few. Of these, river recreation is a rapidly expanding source of economic productivity that generally increases with increased instream flow up to some optimum threshold that maximizes fish survival and reproduction (Walsh et al., 1987; Ward, 1987; Shelby et al., 1992).

River recreation activities generate comparable revenues to those generated by market-based diversionary water uses (Douglas, 1998; Loomis and Cooper, 1990). Recreation expenditures by anglers provide jobs and income to local residents which support regional economic growth (Cordell et al., 1990). Angler spending has been used as the basis for estimating the regional economic estimates of local income and jobs in several water-limited systems of the western United States and Mexico (i.e. Harris and Rea, 1984; Douglas and Harpman, 1995; Loomis, 2008; Ojeda et al., 2008). However, angler expenditures also represent significant contributions to the regional economies of places that do not currently suffer from water scarcity.

This paper estimates the economic contribution of angling to the lower Connecticut River Watershed (CRW) economy. We draw upon existing angler expenditure, river flow, and geographic information system (GIS) data to relate anger use of the lower CRW and expenditures to river flows. We then translate angler expenditures into state income and employment using a regional economic multiplier.

We focus on the lower CRW (the reach of the river within the state of Connecticut) because the Connecticut River is among the most dynamic, densely occupied, and regulated working river systems on Earth. The CRW as a whole, and the lower CRW in particular, host a wide range of competing land uses making it a particularly interesting and important case (Figure 1). The lower CRW serves as a prime example of the numerous trade-offs required of environmental managers and policy makers who must continually prioritize competing water uses. The waters along the Connecticut portion of the CRW are used for mills, transportation, irrigation, power plant cooling, hydroelectric generation, and, most importantly for the purposes of this paper: outdoor recreation (Griswold, 2012; USFWS, 2007; Crumbler, 1991; Gordon, 1983; Buck & Rankin, 1972). Moreover, to our knowledge, no one has attempted to quantify the value of instream flows in this river or elsewhere in New England.



Source: Taken from the National Landcover Dataset (2001).

Fig. 1. The location of the lower Connecticut River Watershed (CRW) situated within the entire CRW and the land uses

1. Methods

1.1. Data sources. We used data from the most recent (2006) USFWS National Survey (USFWS, 2007) on the total freshwater expenditures in Connecticut to estimate the total economic impact of recreation in the lower CRW. The survey reported data at the state level and included expenditures for the entire state. For this project, we determined the proportion of the land area of Connecticut that was covered by the CRW to estimate the portion of the expenditures that likely occurred within the lower CRW (assuming a uniform distribution of outdoor recreational activities across the state). We obtained the CRW boundary from the national watershed boundary dataset that is freely available at: http://water.usgs.gov/GIS/huc.html. This site supplies geospatial watershed data at a variety of scales ranging from the sub-basin to watershed level.

1.2. GIS analysis. The expenditures attributable to the lower CRW were estimated by calculating the area of the lower CRW relative to the total area of the state of Connecticut. The area of the lower CRW was determined by clipping the NLCD dataset by the lower CRW boundary layer using ArcMap 10 (ESRI, 2010). After estimating the area of the lower CRW relative to the total aerial coverage of Connecticut, we estimated freshwater recreation-based expenditures by multiplying the total expenditures by the percent land area covered by the lower CRW. While we performed an analysis for a subsection of a large New England river, this method could be applied to a wide range of watershed sizes. In the case of smaller watersheds it may be more appropriate to use county-level data to generate data about the area of the watershed relative to the size of the counties that encompass the watershed, although the scope of analysis may depend upon data availability.

1.3. Translating expenditures to income and jobs. Following Loomis (2008) and Harris and Rea (1984), we used the economic input-output life cycle assessment (EIO-LCA) model to convert expenditures to supply-chain inputs into the economy and employment for each of the freshwater fishing-associated sectors of food, lodging, transportation, and equipment (Carnegie Mellon University Green Design Institute, 2008). Unlike other regional multipliers like RIMS II (Haimes, 2009) or IMPLAN (Olson & Lindall, 2004), EIO-LCA has a freely available web interface that can be used to estimate total economic output, jobs, or emissions for an industry. We employed the 1997 combined state model and built a custom EIO-LCA based on the sectors of (1) scenic and sightseeing transportation and support activities for transportation; (2) food services and drinking places; (3) lodging in the form of camping; and (4) equipment. We chose camping as a conservative estimate of lodging expenditures because in-state residents – who tend not to stay in hotels to engage in outdoor recreation – are responsible for the majority of hunting, fishing, and wildlife watching within the lower CRW. We parsed the combined food and lodging expenditures in the USFWS (2007) report by using the proportion of food and lodging from the US Census Bureau (2001) National Survey of Fishing Hunting and Wildlife-Associated Recreation for Connecticut. We used this estimate because it was the last time these figures were reported independently by sector.

We correlated angler hours (fishing effort) with mean monthly flow (fide Brown et al., 1991; Duffield et al., 1992) using data from Davis (2011) to examine the relationship between streamflow and economic output. We removed outliers from this dataset on dates with high fishing intensity regardless of flow rate (e.g. opening day for trout fishing, Memorial Day Weekend). Streamflow data were calculated as mean annual river flow in million gallons per day (MGD) at Thompsonville, CT using USGS gauging station data on flows from October 2007 through May 2012 (covering the entire instrumental record). Thompsonville is the most southerly USGS gauging station on the Connecticut River that reports river discharge data rather than just gauge height alone. We used the regression equation from this analysis to convert annual state income and jobs from CRW recreation to dollars and jobs per MGD.

A large proportion of water in the Connecticut section of the CRW is diverted for human consumption, irrigation, and manufacturing. We used authorized withdrawal and diversion data for the Connecticut portion of the CRW (Gannon, 2007) to convert the amount of water withdrawals in MGD to recreation-based income and jobs in the lower CRW based on the economic output of mean annual river flows.

2. Results

2.1. River recreation contributions to the lower CRW economy. The lower CRW covers 28.5% of the land area of Connecticut. Total freshwater fishing revenues for Connecticut totals \$243 million annually (USFWS, 2007), meaning that river recreation in the lower CRW generates \$62.8 million a year. The EIO-LCA model suggests that angler expenditures in the lower CRW contribute \$74.2 million annually in supply chain revenues and support approximately 1660 jobs to the Connecticut's economy. These include both direct jobs in the recreation industry (e.g. guides, boat charters) as well as indirect jobs in surrounding retail, food, and lodging establishments.

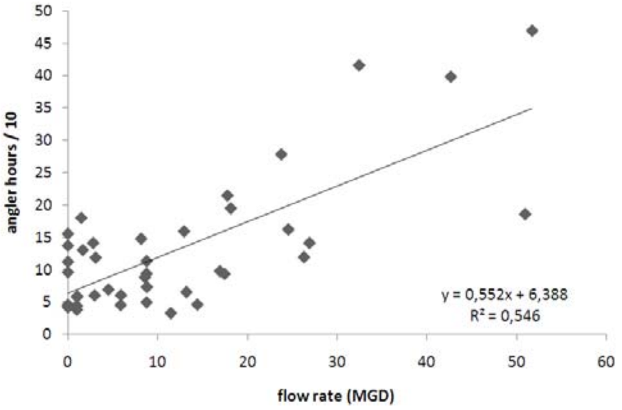
Table 1. Recreational fishing-associated expenditures, income, and jobs in the lower Connecticut River Watershed

River flows	Discharge (MGD)	Expenditures	Income	Jobs
Mean annual flow	11064	62.8	74.2	1660
All authorized withdrawals	6353	36.1	42.6	953
Return/withraw 25%	1588	9.0	10.7	238
Return/withdraw 50%	3177	18.0	21.4	476
Return/withdraw 75%	4666	27.0	32.1	714

Note: The table presents the economic effect of removing or returing 25%, 50% and 75% of the current authorized withdrawals to the river. Discharge is in million gallons per day (MGD). Expenditures and income are reported in millions of dollars.

2.2. Angler hours versus river flow rate. We identified a significant positive relationship between angler hours and river flow in the lower CRW ($P = 0.0001$, $R^2 = 0.54$) (Figure 2). While there is presumably some upper limit to the increase in recreation with river flow where more visitors will cease to use the river at high levels or flood conditions, our data indicate that in general, greater in-stream flows are related to more angler activity.

The linear relationship between angler intensity and stream flow, when combined with the EIO-LCA models, suggests that the currently authorized diversions from the lower CRW, which total a surprising 6353 MGD (~ 30% of total potential flow of water within the lower CRW) (Gannon, 2007), cost the region \$36 million in angler expenditures. These expenditures would provide approximately \$40 million per year in total revenues, and nearly 1000 jobs (Table 1). Increasing diversions by an additional 25% would lead to a large reduction in economic productivity in the recreation sector, which would cost the state almost \$11 million per year and lead to the loss of more than 200 jobs. Reducing water diversions by the same amount would boost the economy accordingly.



Source: Data taken from Davis (2011).
Note: *P* = 0.0001.

Fig. 2. Relationship between Connecticut River flow rate in million gallons per day (MGD) versus fishing intensity (angler hours/10)

3. Discussion

Our results demonstrate that river recreation has a substantial impact on the economy of the lower CRW. Increasing water diversions in highly urbanized regions of the CRW (like Connecticut) will have negative economic impacts on southern New England. Our results highlight the value or river recreation and the economic importance of maintaining healthy fish habitat that supports the fishing industry. Not only do instream flows support the economy, but the alteration of stream flow can have direct and substantial effects on regional economic productivity and employment. Further, such economic value could be threatened by future water withdrawals without sustainable watershed management.

Our findings show that investments in managing the health of stretches of the CRW in Connecticut and the larger CRW as a whole through flow restoration can have large potential pay-offs. Improving the flow and allowing for the reestablishment of natural season flood cycles within the CRW can generate both new jobs and more revenues both in Connecticut and across the three other watershed states. Conservation and restoration of the CRW is not simply cost, it is an investment and serves as another reason speaking in favor of the protection and the renewal of rivers and wetlands within New England.

The link between protecting instream flows and maintaining river health is obvious. Many large bodied sport fish, such as brook trout, shad, and Atlantic salmon, require deep fast moving river and stream habitat, habitat that is reduced when stream flow decreases (McCargo & Peterson, 2010). Even in the Northeast, where water shortages have not traditionally been a problem, withdrawals from rivers and streams have grown to the point where they are beginning to have a pronounced adverse effect on the availability of habitat for many of the fish favored by anglers (Kanno & Vokoun, 2010). On top of this threat, disruption of seasonal flood cycles also interferes with fish spawning and places a further pressure on fish populations (King et al., 2009; King et al., 2010). In the Connecticut River Basin, the combined effects of reduced stream flow and the disruption of seasonal floods have already resulted in significant reduction in biodiversity, which eventually will have an impact on recreational fishing (Kanno & Vokoun, 2010). Projections suggest that if future stream flow continues to decrease at current rates, there could be as high as a 33% increase in monthly brook trout mortality, putting this key angling species at risk of extinction (Xu et al., 2010).

Freshwater flows in tidal rivers such as the Connecticut (which experiences a tidal effect 67 km northward through Hartford, CT) can also have tremendous effects on saltwater ecology and thus saltwater recreational revenues. For example, Atlantic cod was among the most economically valuable and desired sportfishing species in New England until its population crashed. It is often thought of as an offshore, deepwater species, or one that feeds on crustaceans. However, it used to swim upstreams chasing herring, shad, and alewife as prey. Likewise, many anadromous fishes such as Atlantic salmon have historically depended on the lower CRW for breeding, living out the rest of their lives at sea. These species are beginning to return to this region, but their recolonization and success depends upon undammed rivers and healthy instream flows (Letcher and King, 2010). This suggests that promoting freshwater instream flows will not only promote freshwater angling activity, but that it could also bolster Connecticut's $650 million saltwater angling industry.

Conclusion

This study demonstrates the economic importance of non-market recreational uses of water. Others have used regional economic multipliers to estimate the value of instream flows (Hickey & Diaz, 1999; Loomis, 1998), however our approach stresses the economic contributions of instream flows to the economies of non-arid regions. Moreover, the method we employed in the current study incorporates freely available data and multipliers, meaning that it could be readily applied to any number of watersheds across the country regardless of size. Our results indicate that decreasing water withdrawals could have major impacts on the economy of the CRW. While tradeoffs are inherent in water resources management, estimating the value of water left in the river is an important first step in understanding the ramifications of water withdrawals on ecosystems and regional economies. Underestimating the value of the recreational or aesthetic opportunities provided by water can lead to the development of water allotment schemes that fail to recognize the value of instream flows to local and regional economies.

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