



Session 3: Reconciling Stocking, Management and Conservation

J1

Evaluating Spatially Explicit Strategies for Addressing Short-Term Socioeconomic and Conservation Trade-Offs in Recreational Fisheries

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Recreational fisheries are generally typified by at least two primary objectives—conserving wild fish populations and achieving if not maximizing human well-being of fishers and other stakeholders. Trade-offs between these two objectives commonly exists in in the short-run, in which management decisions often must be made. Though stock enhancement has commonly been proposed to potentially circumvent this trade-off, recent research suggests this may be generally unlikely when applied in a homogeneous manner across a landscape. However, a promising approach to addressing this trade-off, using stock enhancement and other management actions, is to employ spatially diversified approaches. Here we explore such an approach using a bioeconomic model representing key dynamics and behaviors of fish populations, decision makers and anglers throughout a spatially explicit landscape. We find that at a landscape scale, win-win approaches to inherent conservation-socioeconomic trade-offs are possible to obtain with stock enhancement. We further describe the specific conditions under which such outcomes are most likely, and present management strategy evaluation tools for facilitating decisions of what actions to implement in which areas. The results were sensitive to societal valuations of wild versus hatchery fish, as well as the importance of travel costs in how anglers select sites. A key implication of this work is that past recreational fisheries science approaches of comparing the relative benefits of alternative management actions may be more usefully reframed to consider where to apply a range of alternative approaches, including stock enhancement.



J2

Value of Put-And-Take Fisheries as a Tool to Satisfy High Angling Demand in Alberta

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Compared to most Canadian provinces, Alberta has few fish-bearing lakes. With only 800 self-sustaining lake fisheries and another 300 stocked, primarily with trout, we have a ratio of nearly 400 anglers/lake, compared to the 2 anglers/lake in Saskatchewan, Manitoba and Ontario. The importance of trout stocking in Alberta cannot be understated, a quarter of all angling effort in the province is estimated to occur on trout-stocked fisheries.

Since 1997, Alberta Conservation Association has stocked approximately 63 ponds with 20+ cm rainbow trout, creating fishing opportunities in areas of the province where they would not otherwise exist. Our ponds are small and shallow (mean = 2.6 ha and 2.9 m respectively), frequently winterkill and most only support a summer put-and-take fishery. Stockings average 1,500 fish per event, occur immediately after ice off and include trout obtained from private growers and government hatcheries. The rising cost of catchable trout led us to evaluate our trout stocking activity. This included evaluation of trout survival, angler use, stocking rates, avian predation, and the species and strains of trout stocked. Despite highly variable trout survival (from 7.5% to 99.7%) we were surprised to find that angler satisfaction with our ponds is often high while angler use at some ponds is very high (up to 5,000 h/ha). Historical stocking rates were only loosely related to angler use while deterring avian predation is both difficult and costly. Stocking brown trout helps diversify and sustain fisheries in ponds that overwinter and different rainbow trout strains impact harvest rates.



J3

Can Stocking Cure the Collapse of Inland Recreational Fisheries? The Case of Walleye (*Sander vitreus*) in Alberta, Canada

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Recreational fisheries are globally susceptible to collapse. One example is the recent collapse of Walleye (*Sander vitreus*) populations in Alberta, Canada. To help improve recovery, a large-scale stocking program was implemented in the mid-1980's and continues to date. The objectives of this study were to 1) evaluate the current population status of Walleye in Alberta; 2) determine the environmental indicators for stocking success, and 3) analyze whether stocking helps recover collapsed recreational fisheries. Overall, Walleye are now absent/extirpated from 40% (48/118) of the lakes that were previously stocked, followed by 27% (32/118) of the lakes which now have populations in a collapsed/vulnerable status, and only two lakes support stable populations. Despite an enormous level of stocking, there was no improvement in the status of Walleye across the Eastern Slopes, Parkland-Prairie or Northern Boreal ecoregions. Lake area, and not stocking intensity (or other variables), was the best predictor for stocking success. Stocking in Alberta should act as a cautionary tale, where management should be aimed at the causes of decline rather than symptoms for recovery



J4

Crowd Funding a Marine Stocking Program in Less than 48 Hours

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Stocking of any fish species is a time-consuming process often requiring months of careful preparation and planning with funding sometimes needing to be secured more than a year in advance to allow for capture and conditioning of broodstock animals. The timeframes and costs of marine stocking programs can often be even greater due to the inherent difficulties of culturing marine species.

This case study will detail how Recfishwest and Halco Tackle Company took less than 48 hours to crowd source the funding necessary to stock 50,000 Pink Snapper into Cockburn Sound in Western Australia.

The case study will look at the background to the stocking event and factors behind successfully empowering the recreational fishing community to dig into their own pockets to release fish that will not grow to legal size until 2020. This presentation will explain how Recfishwest were able to maximise the level of community engagement from this project and how the project is still providing ongoing benefit to recreational fishing in Western Australia.

In addition the case study will look at the way this stocking program was able to change the direction of social commentary following a fish kill event and the subsequent reaction of government after witnessing the depth of passion and level of stewardship displayed by recreational fishers.



J5

Relationships Between Filial Number on a Fish Farm, Survival Rate, and Vulnerability to Angling of Ayu, *Plecoglossus altivelis*, After Stocking into a Natural Stream

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Hatchery-reared fish are domesticated and are vulnerable to angling. These fish may be unable to adapt to the wild environment after several generations under artificial conditions. Domesticated ayu could be less vulnerable to angling, as angling for ayu is typically passive and uses the territory behavior of the fish. We conducted an ayu farming, stocking, and angling experiment. In 2010, 10,000 fin-clipped fish per strain were stocked into the Ara River, and the survival rate and vulnerability to angling were compared between fifth filial generation (cultured for five generations; F5) and F9 fish. Ayu were a suitable fish for this study, as they have an annual life history. A similar experiment was conducted between F1 fish obtained from native fish and F6 fish in 2011, F2 and F7 in 2012, and F3 and F8 in 2013. Throughout the 4-year survey, survival rate and vulnerability to angling decreased with increasing filial generation, particularly after the eighth generation. Interestingly, F1 fish also had a low survival rate and less vulnerability to angling in the river, mainly because F1 fish were unable to adapt to artificial conditions (i.e., quite high density and pelleted feed). As a result, F2 to F7 ayu were moderately domesticated and retained some wild character.



J6

Angling for Endemic Fish as a Conservation Tool: The Challenge of Miyabe Charr Recreational Fishery in Lake Shikaribetsu, Japan

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Under sound management design, recreational fishery can be a conservation tool for fish population since it provides monitoring research data and socioeconomic value for fish population. Miyabe charr *Salvelinus malma miyabei* is an endemic fish inhabits only in Lake Shikaribetsu. For harmonizing conservation and recreational use of Miyabe charr population, a management program “Greatfishing in Lake Shikaribetsu” have been carried out since 2005. Scientific assessment based on stock assessment and economic questionnaire reveals that 1) tagging study involving anglers reveals that Miyabe charr population was high level, 2) mandatory daily catch report of anglers was confirmed that catch-per-unit-effort of anglers indicate stock level exactly, 3) fishing regulation such as catch and release of Miyabe charr was validated to regulate fishing pressure effectively, and 4) anglers in Lake Shikaribetsu came from all over Japan, and their estimated total consumption of fishing travel (240,000 US\$) was estimated to be more than 30 times of running cost of management program. By considering these results, angling for Miyabe charr act as conservation tool.



J7

Conserving the Legendary Hump-Backed Mahseer of South India: The Role of Recreational Anglers in Elucidating the Impact of Historic Stocking Practice on Current Population Status

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Of the 17 currently validated species of mahseer (*Tor spp.*), the giant hump-backed mahseer represents one of the most highly prized freshwater game fishes in the world. Always geographically vulnerable due to its limited endemism to South India's River Cauvery system, the species has also faced long-term and escalating ongoing threats from a range of anthropogenic stressors, including river engineering and destructive fishing practices. Incorporating records dating back to the early 1900's, this paper examines the history of the development of the River Cauvery recreational fishery and explores extensive photographic and angler-catch data. In examining records of individual fish ranging in size from 1 to 119 lbs (0.45 – 53.5 kg), the dataset has not only revealed a dramatic increase in catch per unit effort (CPUE) over recent years, but has also evidenced the appearance of a second species of (blue-finned) mahseer (*Tor khudree*) during the early 1990's. Originating from a well-intentioned stock augmentation programme initiated during the 1970's, by 2012, the invasive success of *T. khudree* accounted for more than 99 percent of the mahseer community, leaving the endemic hump-back struggling to recruit and an ageing population spiralling towards extinction. Lacking contemporary ecological survey data, this paper investigates the value of recreational angler derived data for informing the performance of mahseer populations throughout South and Southeast Asia and how these findings have affected positive changes in attitude towards national stocking policy. With further reference to the associated societal and economic benefits of recreational angling to indigenous communities, we discuss the prospects and challenges of saving one of the planet earth's most iconic freshwater fish from extinction.



J8

"God's Little Helpers": Examining the Socio-Cultural Value of Small-Scale Atlantic Salmon Hatcheries in Norway, Wales, and Germany

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This article explores the socio-cultural value of small-scale, voluntarily operated wild Atlantic salmon (*Salmo salar*) hatcheries and similar salmon cultivation efforts using three case studies in western Europe. Salmon hatcheries in Norway, Wales, and Germany have been used for the last several centuries as a means of enhancing recreational salmon fisheries, a practice that has come under scrutiny in recent decades as they have recently gained a (contested) role in the future conservation of threatened populations. Using qualitative methods, we examine the wider value of these voluntarily operated hatcheries as more than simply a means of salmon production. We find that these local hatcheries facilitate community organization around salmon conservation activities, provide culturally important recreational and service-oriented activities for primarily middle and late-aged men, and act as centers for teaching and the transfer of local ecological and cultural knowledge from one generation to the next. We conclude by arguing that the socio-cultural value of these salmon hatcheries in western Europe should be considered in addition to their biological conservation value in producing salmon when deciding assessing the future role of these facilities.



J9

Yukon's Innovations in Encouraging Recreational Fishing While Conserving Wild Lake Trout Populations

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The Yukon Territory features one of the highest per capita recreational fishery rates in Canada. There is a long-standing tradition and established culture of recreational fishing for large, wild Lake Trout in many accessible Yukon lakes. Unfortunately, recent government surveys have indicated that fishing and catch rates are proving unsustainable for many populations of Yukon's treasured Lake Trout. All parties involved in fisheries recognize the need for aggressive Lake Trout management but do not want to limit overall participation in the recreational fishery. As a result, the Government of Yukon, Yukon Fish and Game Association and other management bodies have developed a three-pronged approach to managing Lake Trout while continuing to encourage recreational fishing. This includes 1) managing angler behavior, 2) targeting other species (i.e. Northern Pike and Lake Whitefish), and 3) utilize the existing stocking program of pothole lakes to re-direct fishing pressure. This presentation will provide an overview of the issues and management around recreational Lake Trout fishing with some examples of innovative partnerships encouraging continued recreational fishing. Specific examples will include, an educational and outreach partnership between the Yukon Fish and Game Association and the Government of Yukon whereby youth were taught how to catch Lake Whitefish and develop an entertaining instructional video. In addition, the presentation will highlight various recreational fisheries projects funded by the Yukon Fish and Wildlife Enhancement Trust in order to support the conservation of Yukon's wild Lake Trout populations.



J10

Recreational Fisheries Simulator - A New Planning Software to Simulate the Impact of Harvest Regulations and Stocking Following Bio-Economic Feedback Principles

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We present a novel bio-economic planning software that simulates fisheries, conservation, social and economic outcomes to be expected for a range of harvest regulations (minimum-length limits, harvest slots, bag limits) and stocking policies (which vary by amount and size of fish released). The fish population ecology follows an age and size-structured population biology with multiple size- and density dependent feedback processes. The anglers simulated in the model follow a multi-attribute utility function calibrated to the behaviour of German anglers. The user can represent different angler types to understand the relevance of regulations and stocking for heterogeneous angler populations. The software offers parameter settings for a range of freshwater fish species that are either naturally recruiting or culture-based. The software can be used to compare the likely outcome of a range of harvest regulations and stocking policies against a set of management objectives. By way of the graphical representation of the results the user is “forced” to evaluate trade-offs. The software is designed to be used in adaptive management processes by local level fisheries managers in central European fishing clubs. It is free of charge and available both in German and in English.