Yellow Flag, *Iris pseudacorus*, has no observed effect on fish and macroinvertebrate communities in a Montana Stream

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Abstract

Invasive species are a preeminent threat to biodiversity and can alter ecosystem function. Yellow iris, *I. pseudacorus*, is an aquatic macrophyte Native to Europe and parts of Asia that has been introduced to many parts of the United States, including Montana. Observed effects of invasions include narrowing of streams and establishment of dense monoculture stands. Although the impacts of invasive plants are often associated with negative ecosystem responses researchers have suggested that narrowing and meandering caused by the establishment of Iris may create fish habitat. We examined a coolwater stream in Western Montana and found no differences in fish and macroinvertebrate communities in stream reaches with and without established stands of iris.

Introduction

Invasive species are one of the primary pressures on threatened and endangered species. In 1998 over 50% of listed species were negatively impacted by introduced species (Wilcove et al 1998). Invasive and exotic species can create large areas that are biotically homogenous (Swartz et al. 2006). They can also alter ecosystem functions such as fire regime and nutrient cycling (Randall 1996; Emery & Perry 1996). Successful invasions of species may have significant economic effects if ecosystem services, such as regulation of water quality are altered (Vitousek 1990). Invasive species may also indirectly effect ecosystems by altering trophic cascades (Vitousek 1990). Worldwide there are many invasive species and the number continues to grow. For this reason, with a few exceptions, there is little quantitative data on any single invasive species (Blossey et al. 2001).

Non-native invaders of streams and wetlands have had major impacts on many ecosystems throughout North America. One notable example, purple loosestrife, has been shown to alter nutrient cycling (Emery and Perry 1996) and decrease biotic diversity in streams and wetlands (Schooler et. al 2006), which may lead to changes in wetland ecosystem functions. Much effort has been put into control of purple loosestrife in the United States, but there has been criticism because of reliance on observation, and limited quantitative data (Blossey et al 2001).

The yellow flag, *Iris pseudacorus*, is a popular plant used in water gardens and in other ornamental plantings. *I. pseudoacorus* is of Eurasian origin, and has escaped in significant quantities in many regions of the United States and New Zealand (Sutherland 1990). The plant continues to be sold on the internet and by garden retailers nationwide. *I pseudacorus* is a nitrophile that can live in oxygen-poor soils and its habitat ranges from water-saturated to moist soils. It has been shown to decrease soluble organics in its habitat by 25% in a year (Sutherland 1990). When the plant does escape, it often lines the banks of streams and wetlands and can form a dense monoculture. Enabled by its heavy rhizomes, *I. pseudacorus* can form vast areas of vegetation that encroach on open areas of water. Broken rhizomes may flow downstream and readily take up residence (University of Florida IFAS 2008). These characteristics enable the plant to spread quickly and at the same time made eradication difficult. This plant has the possibility of becoming a major problem throughout the nation by modifying stream ecosystems and out-competing native aquatic plants. Yet only six states, including Montana, have identified the plant as a noxious weed or invasive (plants.usda.gov), and there is little literature on *I. pseudocorus* as an invasive.

Despite the obvious negative impacts on stream ecosystems, it has been proposed that the yellow iris, *I. pseudacorus* is having positive impacts on the Crow Creek ecosystem in the Flathead Valley of western Montana. The iris narrows the stream channel and appears to create meanders in the human-impacted stream. Here we determine if *I. pseudacorus* is altering the natural biotic communtities of Crow Creek. I hypothesize that there will be increased fish and insect diversity in stream reaches with *I. pseudacorus*.

Study Area

This study took place on Crow Creek, Lake County, Montana, between the confluence of Crow and Spring Creeks upstream and the outflow into Lower Crow Reservoir downstream.. Crow Creek is a mid-sized coolwater stream originating from snowmelt in the Mission Mountains. It has significant input from irrigation canals which warm the stream once it reaches the valley. The stream has had significant invasion of yellow iris. The date of invasion of the stream is unknown, but *I. pseudacorus* was first recorded on the nearby Ninepipe National Wildlife Refuge in 1958 (Preece 1964). From the severity of the invasion, it can be inferred that *I. psuedacorus* has persisted for many years on Crow Creek.

Methods

Five paired reaches of stream were selected, with each pair consisting of a 75m reach with abundant *I. pseudocorus* and an adjacent, characteristically similar 75m reach with less than 10% of the bank lined with *I. pseudocorus*. To compare Iris and no Iris stream reaches, I collected samples of invert community, fish community, DO, Temp and cond. in each of the ten sites. Within each reach I took 5 randomly placed macroinvertebrate samples using a Surber sampler. In order to decrease variation, samples were located only in riffles over medium sized rocky substrate. Samples were preserved in ETOH andspecimens were counted and identified to genus in the laboratory using Merritt, Cummins and Berg (2008).

Fish were collected using a 3-pass depletion-style electrofishing sampling method. We used 2 Smith-Root electrofishers, 250V, 30Hz, duty cycle 20 Block nets were deployed at both ends of the stream reach to prevent migration into and out of the reach. Fish were identified to species, weighed and measured after each pass.

Water quality measurements, oxygen, conductivity and temperature were taken using a YSI-85 meter. Average flow was taken by timing how long it took an orange to float a known distance downstream.

All statistical analyses were performed in SYSTAT 9. Analysis of insect and fish communities between Iris and no Iris stretches (hereafter referred to as treatments) was carried out using principle components analysis. Paired t-tests were used to test for differences in species diversity, abundance and richness between treatments. Nested GLM was used to analyze differences between treatments with physical data as factors and ANCOVA was used to decrease inherent variation among sites.

Results

Physical parameters

When physical parameters were analyzed between treatments with unpaired samples using a nested general linear model, all physical parameters showed significant among site differences, but there were no between treatment differences (Table 1). Site differences did not show a predictable pattern when they occurred among different parameters, and site differences were not important in this study, so they were not analyzed further within the context of themselves . They were important in reducing variation when examining biotic parameters though. When distance from Lower Crow Reservoir was regressed with temperature, there was a significant positive relationship. (p=0.014)

Table 1. Nested GLM of physical parameters

Measure	Source	df	f-ratio	P
Percent DO	Treatment	1	2.603	0.115
	Site	8	55.413	<0.001
	Error	40		
Conductivity	Treatment	1	0.281	0.599
	Site	8	7.507	<0.001
	Error	40		
Average Flow	Treatment	1	3.60E+14	1.000
	Site	8	2.24E+16	1.000
	Error	40		

Macroinvertebrates

Iris had no significant effect on stream macroinvertebrate abundance, diversity, and species richness when sites were examined as pairs (Tables 2 & 3). Abundance approached significance with each reach having higher densities in the Iris stretch than the non-Iris stretch.

Table 2. Macroinvertebrate Composition

Treatment	Reach	No. taxa	No. Organisms	Diversity
Control	1	21	418	2.177047
	2	19	363	1.735635
	3	17	314	1.74198
	4	18	462	2.104074
	5	19	553	1.796841
Iris	1	19	458	2.09591
	2	16	382	1.894244
	3	17	517	1.809556
	4	18	464	1.875082
	5	20	742	1.436529

Table 3. Paired t-test Results

Paired-t	df	t	p
Abundance	4	-2.083	0.106
Richness	4	0.433	0.687
Diversity	4	0.939	0.401

Nested GLM was used to examine the 10 most abundant taxa. There were no significant treatment effects except for the caddisfly genus *Hydropsyche*. This significant result was determined to be an artifact because one site was disproportionately influencing the results, and when it was removed from analysis, the treatment effect became nonsignificant.

Because there were significant among-site differences of stream physical characteristics, diversity abundances of each taxa that makes up 10% of at least multiple samples were analyzed individually using ANCOVA, with percent DO, conductivity, average flow and distance from the reservoir as covariates. None of these taxa, nor diversity exhibited a significant treatment effect ($p<0.05$).

Stream macroinvertebrates exhibited no distinct clustering patterns when examined in principal components analysis with a hierarchical tree. In order to be considered a cluster, distance was set at 0.3, *a priori*. Within this parameter, no grouping emerged when all of the taxa were included, nor did a grouping emerge when only taxa making up 10% abundance of multiple samples were included. Macroinvertebrates did not show distinct, separate communities in stream reaches with *I. pseudacorus* and without.

Nested GLM of proportion of functional feeding groups by treatment showed no significant iris effect. Collectors made up the majority of the individuals across all samples, with 82.9% average proportion, while scrapers made up 9.9% and 7.1%. Across all samples, there was a single individual classified as a shredder.

Fish

I collected a total of 10 species in our electrofish sampling. Longnose dace made up 70.6% of the individuals of all samples, followed by brown trout with 12.6%, rainbow trout with 7.9% and large scale sucker, longnose sucker, smallmouth bass, brook trout, yellow perch, mountain whitefish and rainbow/cutthroat trout hybrid all with approximately 1% or less of total abundance. *Iris pseudacorus* showed no effect on fish in Crow Creek. When pairs of sites were analyzed for differences in abundance, diversity and richness and salmonid abundance, there was no significant Iris effect (Table 4). Although there was no significant treatment effect, linear regression showed a positive relationship between distance from Lower Crow reservoir and abundance of longnose dace (R^2= 0.771, t=5.600, p=0.001). No other species showed a significant relationship. Neither longnose dace nor brown trout showed significant differences in weight or length by treatment (nested GLM, p>0.05) There were too few occurrences of other species to have the power necessary to analyze.

Table 4. Paired t-tests of fish between treatments

paired-t	df	t	p
Abundance	4	-1.2	0.297
Richness	4	0.272	0.799
Diversity	4	0.176	0.869
Salmonid abund.	4	-0.712	0.516

Principle components analysis was used to examine community structure of stream reaches with and without yellow iris. With a distance of 0.3 chosen *a priori* to be the cutoff for grouping in hierarchical clustering, there were no significant differences in fish community by treatment.

Discussion

It has been proposed that *I. pseudacorus* can be beneficial for fish by creating habitat such as undercut banks and meandering flow regimes. In Crow Creek *I. pseudacorus* has invaded heavily and dominates the bank vegetation in the majority of the stream in this study area. I observed large areas where the stream was narrowed due to encroachment of the iris on the stream channel and large areas that I presume to be filled-in backwater areas. While stream width has been impacted by the invasion of the iris, there is no evidence to support either positive or negative impact on water quality characteristics or on fish and insect communities within the stream.

Paired t-tests of diversity, abundance and taxa richness showed no significant difference between iris reaches and control reaches. This is not unexpected, as there were no significant differences in flow by treatment and macroinvertebrate sampling took place in riffles, not along the bank, where most of the impact from iris has occurred. Flow, for many collector-filterer insects, is one of the most important aspects when choosing habitat (Gallepp 1977). Collector-filterers made up the majority of the individuals from all samples. The abundance of filter-collectors is indicative of high FPOM content in the stream. Much of the FPOM input most likely comes from the high number irrigation canal inputs in the stream.

Fish showed neither a significant habitat preference nor different communities in stream reaches with and without *I. pseudacorus*. The homogeneity of species composition may be in part due to the fact that most control reaches were directly adjacent to areas of stream that were colonized by *I. pseudacorus*. The reaches may have been too small to harbor distinct communities, and fish are known to move extensively, even day to day (Bunt et al. 1999) so that species blend or overlap into other reaches.

The significant negative relationship between longnose dace abundance and distance from the reservoir is more likely a function of substrate size. Although there is no quantitative data, I observed a gradient of substrate size increasing with increasing distance from the reservoir. Longnose dace prefer habitat with larger cobble size (Thompson et al. 2001).

Although I did not see an Iris effect on the in stream biotic community in Crow Creek, I do not believe that the iris is having no effect. I propose a thorough quantification of effects of the iris in the riparian zone. Also in future studies I propose experimental removal or herbicide application on large reaches for at least 5 years before sampling begins. The rhizomes are hardy and may persist for multiple years after vegetative die-back, and may require physical removal.

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