

Online supplementary material***There were no environmental or structural differences among pond types***

In order to discern whether there were any *a priori* differences in vegetation structure that might influence pollinator abundance or behaviour independent of dragonflies, we measured vegetation structure at each pond. First, because pollinator behaviour can be affected by shading²⁸, we examined whether ponds differed in their proximity to nearby tree canopy. All pond margins where *H. fasciculatum* occurred had 0% overhead blockage by trees, and there was no difference between ponds with and without fish in their distance to the forest edge (range 20-50 m; t-test; $t = 1.35$; $df = 6$; $P > 0.23$). Further, *H. fasciculatum* is the tallest species on the margin of each pond, and only tall grasses such as *Panicum hemitomom* and *Zizaniopsis miliacea*, which also dominate pond margins, were ever close in height to this shrub. However, because these grasses do not reach full size until later in the summer, they do not likely interfere with *H. fasciculatum* pollination during the spring blooming period.

Finally, if ponds with and without fish differed systematically in their surrounding vegetation structure (especially co-flowering species), this might influence the pollination of our focal species, *H. fasciculatum*. To examine this, we measured percent cover of plant species ($N = 29$ species) at each pond from 20 1m^2 quadrats placed equidistant from each other dispersed across the entire pond margin (distance between quadrats was scaled with pond size). All quadrats were located in the zone of the pond margin where *H. fasciculatum* was most common (generally 2-3 m from the pond edge). We used a Mantel test (10000 permutations) on the Euclidean distance on community composition between each pond (based on multidimensional data on the percent cover of each

species). We found that the similarity of ponds in their community composition did not depend on whether or not fish were present ($Z = 970.96$, $P = 0.68$). This remains true even when we correct for spatial distances between ponds ($Z = -35.55$, $P = 0.39$).



Above, see photographs of a typical fish-free pond (left) and pond with fish (right) (Photo credit: J. M. Chase). Note the similar size, canopy coverage, and vegetation structure.

The shrub in the foreground with the small yellow flowers is *H. fasciculatum*.

Complementary experiment with another plant show similar trans-ecosystem cascades

Sagittaria latifolia, is an emergent aquatic plant that occurs in very shallow waters at the margin of ponds. *S. latifolia* is common throughout the region and is present in the Ordway preserve, but was not present in any of the study ponds. To standardize for environmental factors and density, we obtained 96 reproductive plants from a nearby nursery, planted them in 3.8 l pots with commercial potting soil, and transplanted 12 individuals (4 in each of 3 300 l ‘kiddie pools’ separated by 20 m) at each of the 8 ponds. The *S. latifolia* used in this study were monoecious, and therefore female flowers could not produce seeds without pollinator visitation. Individuals began flowering in mid-July, and continued until late September.

Over a two-week period from late August-early September, we observed a total of 60 *Sagittaria latifolia* flowers to quantify pollinator visitation among all of the ponds. We watched each focal individual of each species for 20 minutes, and calculated the average number of visits/shrub/20min. All insects that landed on the flowers of an individual were recorded and identified to order (e.g. Hymenoptera, Diptera, Lepidoptera). The total number of pollinator visits to *S. latifolia* was higher near ponds with fish, than near fish free ponds (ANOVA $F_{1,6} = 9.05$, $P < 0.02$). There was a significant difference in the composition of pollinator species between pond types (MANOVA: Pillai Trace = 0.23, $F_{2,5} = 8.55$, $P < 0.02$). The number of visits by Lepidoptera (primarily Arctiidae) was not significantly different among ponds with and without fish (Univariate F-test; $F_{1,6} = 0.012$, $P > 0.91$), whereas the number of visits by Hymenoptera (primarily Halictidae) was much greater near ponds with fish (Univariate F-test; $F_{1,6} = 6.64$, $P < 0.04$) (Figure S1).

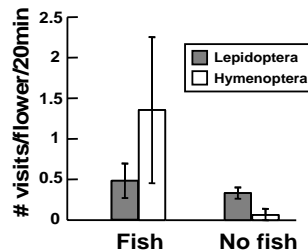


Figure S1. Visitation on experimental *Sagittaria latifolia* at fish and fish-free ponds. Error bars are +/- 1 standard error.

Bees are believed to be the most efficient pollinators of *S. latifolia* (Muenchow and Delasalle 1994). Thus, the effect of reduced pollinator visits near fish-free ponds may be magnified, since those few visits that did occur were predominately from less effective pollinators.

Because our experimental design of *S. latifolia* controlled for many factors that can lead to variation in plant reproductive success, and there were no systematic

differences in the vegetation or environment among the fish and fish free ponds, differences in fruit set by *S. latifolia* in this experiment should reflect differences in the pollinator environment. We found that *S. latifolia* near ponds with fish had 10% higher fruit set (percent of female flowers setting fruit) than did individuals placed near ponds without fish (ANOVA; $F_{1,6} = 16.03$, $P < 0.007$) (Figure S2).

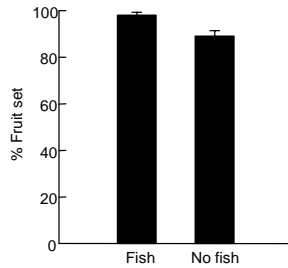


Figure S2. Percent fruit set (percent of female flowers that produced fruits) of experimental *Sagittaria latifolia* at fish and fish-free ponds. Error bars are +/- 1 standard error.

Reference:

Muenchow, G. & V. Delesalle. Pollinators' response to male floral display size in two *Sagittaria* (Alismataceae). *Am. J. Bot.* 81, 568 (1994).