Impacts of native and invasive plants on mosquito ecology and management

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The ecological impact of invasive plants

Increased rates of stream erosion

Lower air quality and reduced filtration

Loss of benefits of wildlife diversity

Common buckthorn

Amur honeysuckle

Multiflora rose

Autumn olive

Vector-borne disease

Increased risk of tick-borne ehrlichiosis due to an increase in tick-host encounter frequency associated with invasive plants (Allan et al. 2010, *PNAS*)

Increased risk of tick-borne disease via effects on leaf litter depth, soil moisture, and host abundance (Elias et al. 2006, *J Med Ent*)

Vegetation and vector mosquito ecology

1) ***Attract*** females for oviposition (habitat discovery)
2) Provide ***food source*** for developing larvae, fueling adult emergence rates (habitat quality)

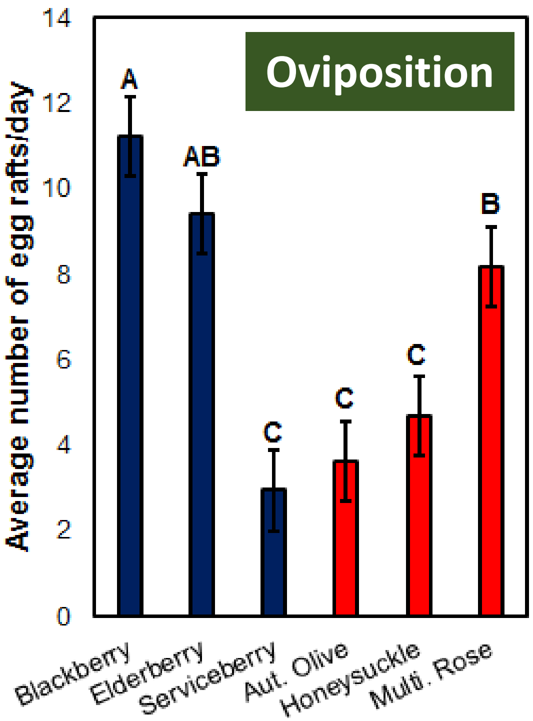
Egg → **Larva** → **Pupa** → **Adult** - - → **Host**

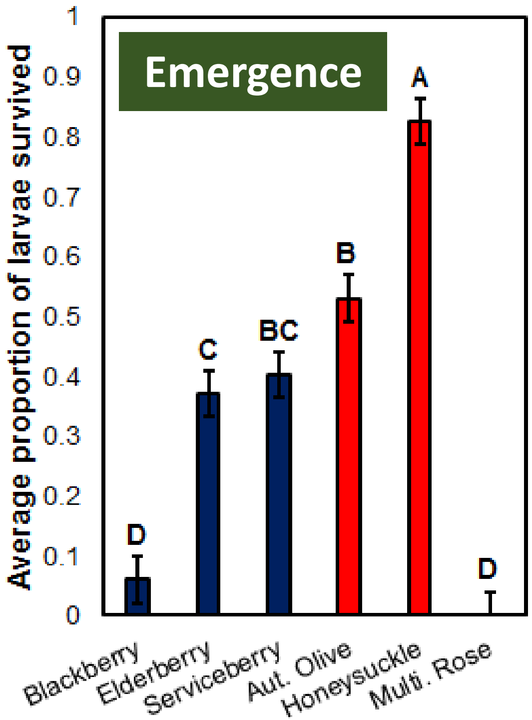
3) Provide ***resting sites*** (local vector abundance)
4) Regulate local ***microclimate conditions*** (vector longevity)
4) Provide ***sugar sources*** for male mosquitoes and females between blood meals (vector longevity)
5) Provide habitat for ***blood-meal hosts*** (vector-host encounter frequency)

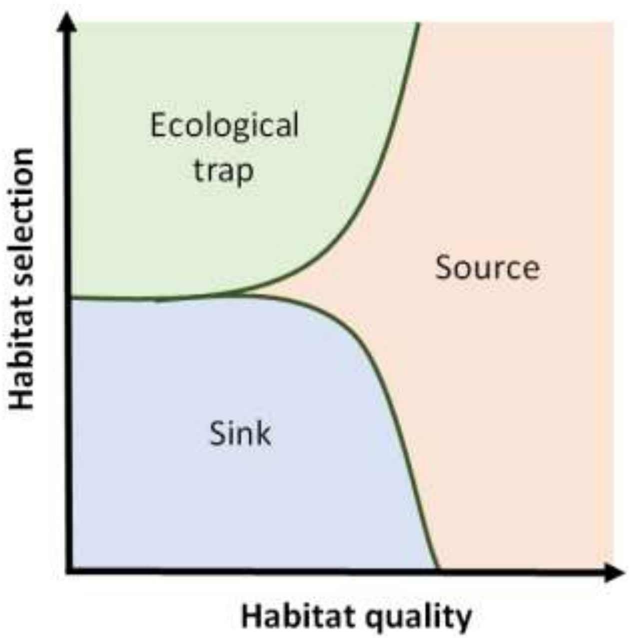
Mosquito oviposition and emergence

A) Blackberry, *Rubus allegheniensis* (native)
B) Elderberry, *Sambucus canadensis* (native)
C) Serviceberry, *Amelanchier laevis* (native)
D) Amur honeysuckle, *Lonicera maackii* (exotic invasive)
E) Autumn olive, *Elaeagnus umbellata* (exotic invasive)
F) Multiflora rose, *Rosa multiflora* (exotic invasive)

Gardner et al. 2015, *Parasites & Vectors*







Mechanisms underlying emergence rates

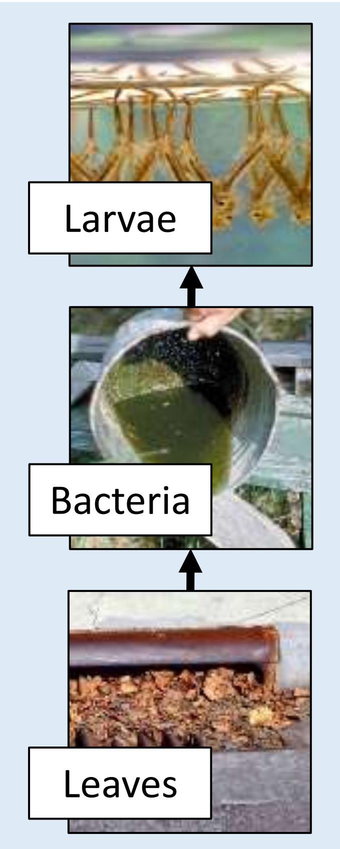
Expt 1: Leaf infusion (2 g leaves/360 mL water)

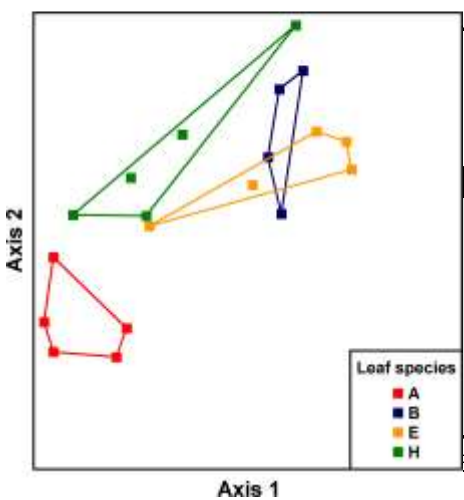
Single species: honeysuckle (H), autumn olive (A) blackberry (B), elderberry (E)
Mixed species: HA, HB, HE, AB, AE, BE

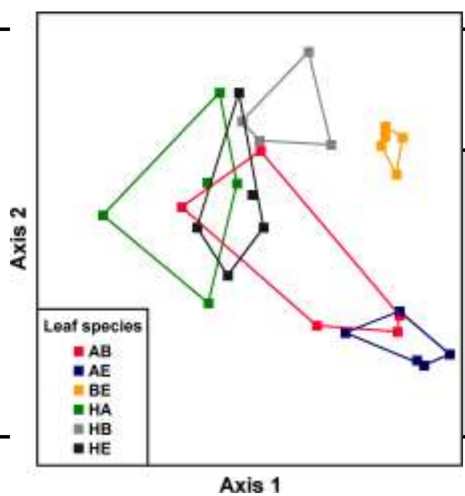
Expt 2: Filtered infusion (10 mg Tetramin/2 days)

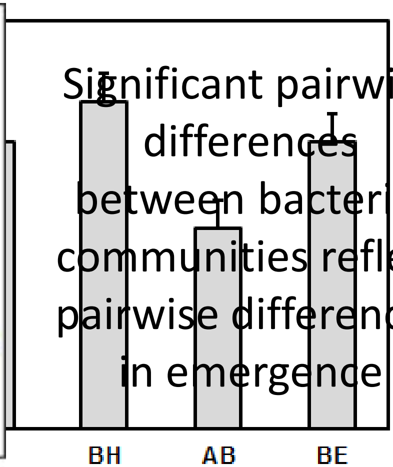
-- Leaf infusion from same batch as Expt 1 with same mixtures as Expt 1
-- Vacuum-filtered to remove all microbes
-- Provided uniform diet across mixtures (10 mg Tetramin on day 0 + 10 mg every 2 days)

Sequence 16S V4 region to identify bacterial OTUs





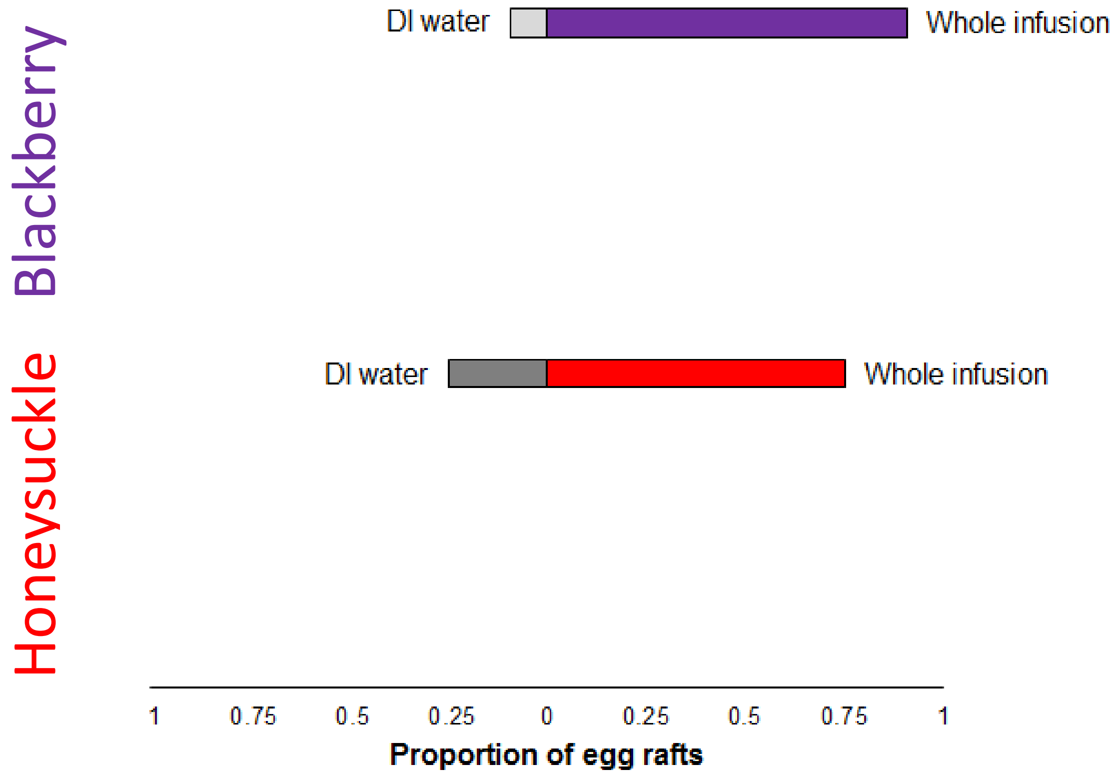




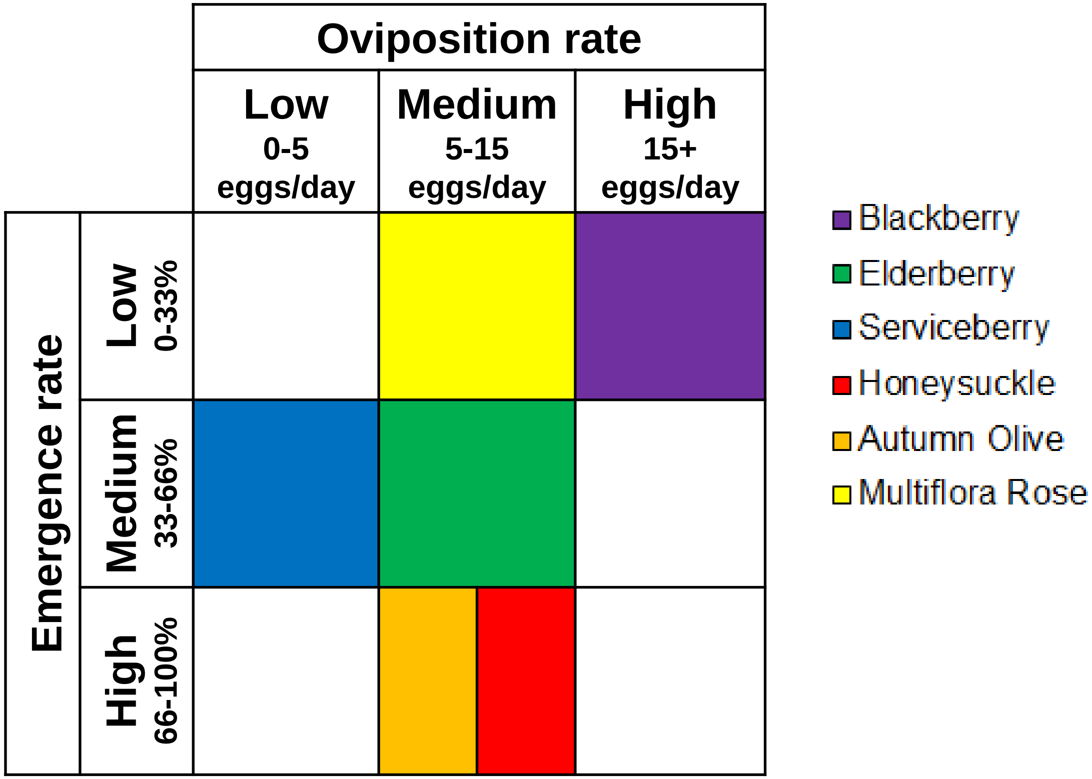
Significant pairwise differences between bacterial communities reflect pairwise differences in emergence

Mechanisms underlying habitat selection

Treatment	Preparation/Importance
Deionized water	Negative control
Whole infusion	Positive control; fermented leaves in water for 7 day period
Microbes only	Pelleted microbes by centrifugation and re-suspended in DI water
Leachate only	Removed microbes by vacuum filtration



Applications for mosquito management



Can these results be exploited for vector control practices that improve the efficacy of and/or reduce reliance on conventional insecticides?

Some exotic, invasive shrubs promote mosquito production.

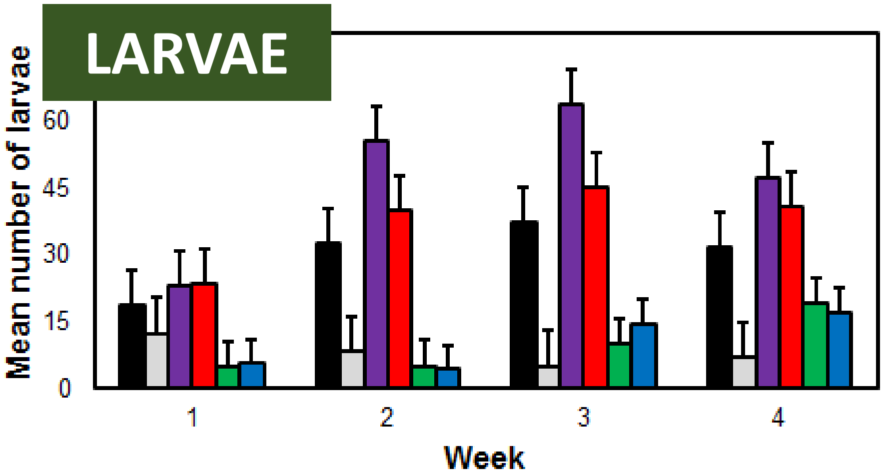
Honeysuckle and autumn olive are associated with high survival and medium oviposition.

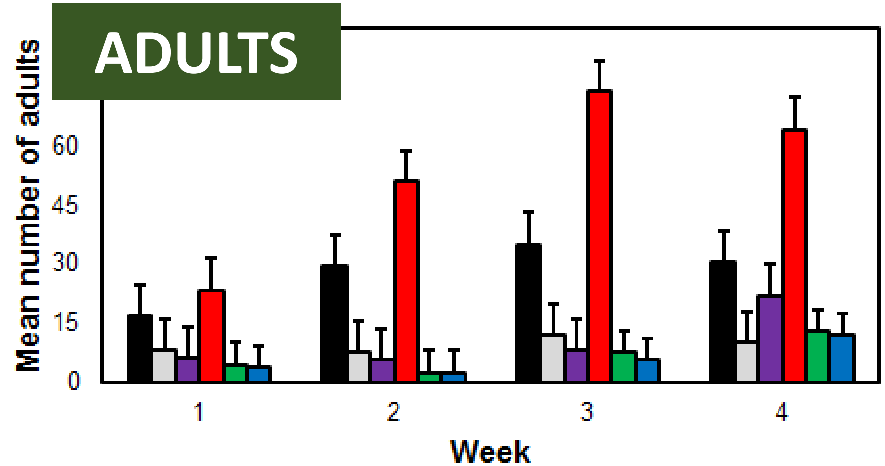
A native plant is an ecological trap for *Culex pipiens*.

Blackberry is associated with low survival and high oviposition; there is a mismatch between selection for and quality of this habitat.

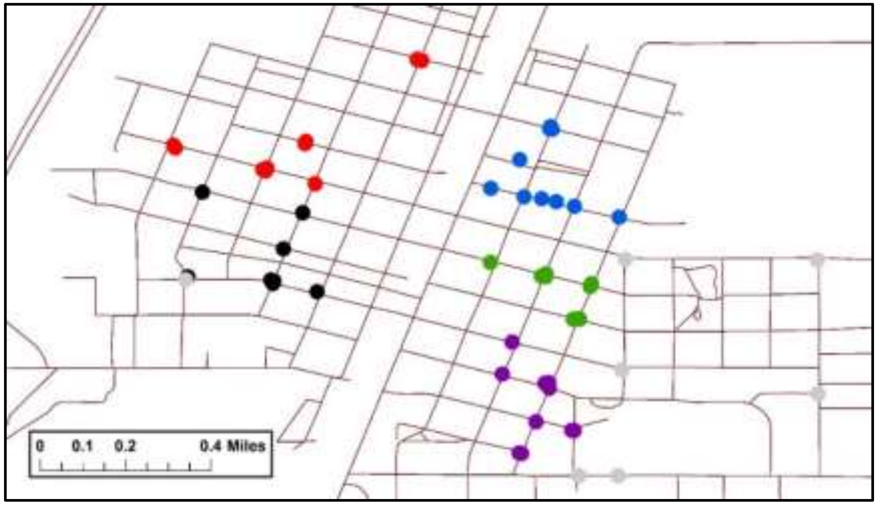
Application: Vector control in catch basins

Can ecological traps be exploited for “attract-and-kill” mosquito control in urban/suburban storm water environments?





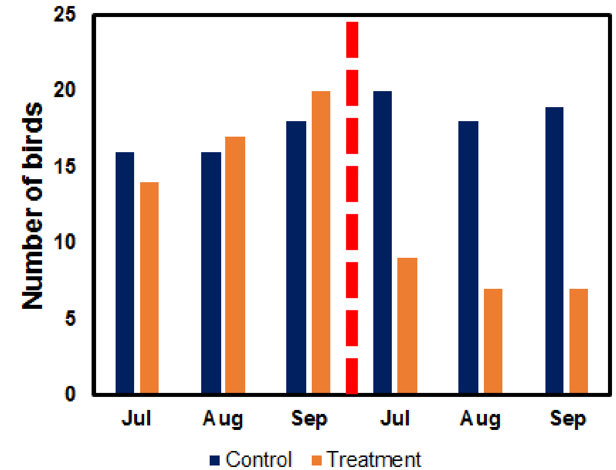
Treatment	Importance
Honeysuckle leaves	Attractants only
Blackberry leaves	Attract-and-kill (natural)
Bti briquette	Insecticide only
Honeysuckle + Bti	Attract-and-kill (artificial)
All leaves removed	Negative control
No modification	Positive control

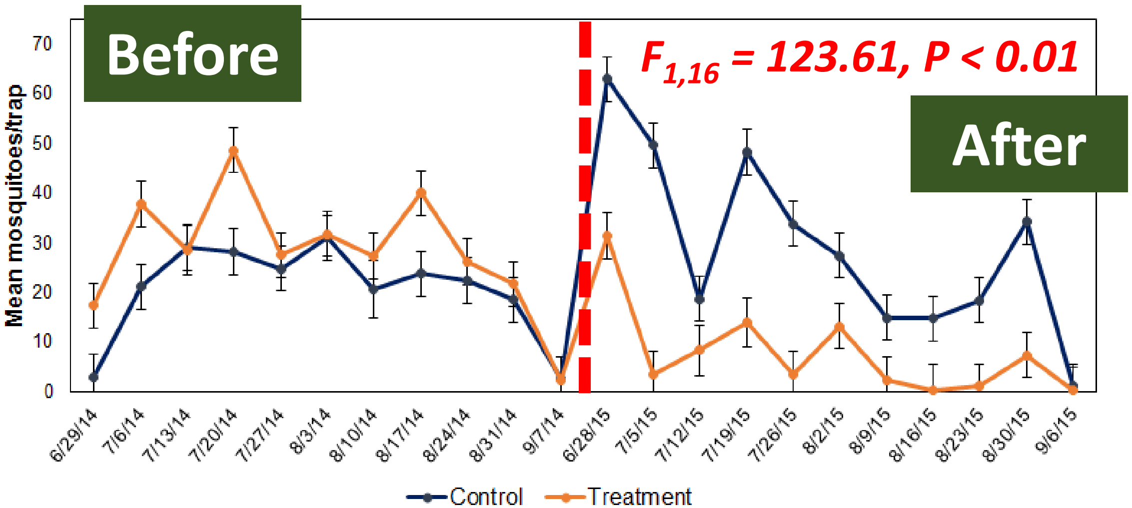


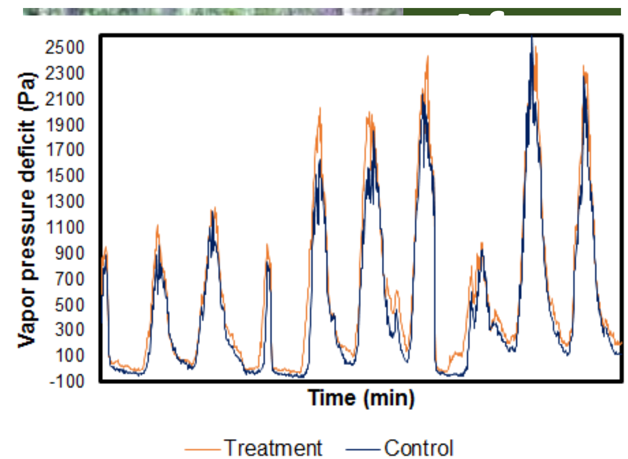
Application: Invasive plant management

Does management of Amur honeysuckle reduce mosquito abundance?

	Year 1 (2014)	Year 2 (2015)
Control Location (0.6 stems/m^2)	Honeysuckle intact	Honeysuckle intact
Treatment Location (1.8 stems/m^2)	Honeysuckle intact	Honeysuckle cleared







$$y_{ijkl} = \mu + L_i + Y_j + LY_{ij} + \varepsilon_{1(ijk)} + W_{(j)l} + LW_{(j)il} + \varepsilon_{2(ijkl)}$$

Research Summary

Leaf detritus from native and invasive plant species in the aquatic larval habitat alters adult emergence and oviposition rates of *Culex pipiens*

→ Variation in emergence rates is related to the different bacterial communities associated with leaves of different plants

→ Variation in oviposition rates most likely is related to phytochemicals leaching from leaves from different plants

Storm water mosquito control application
Ecological traps may be exploited for attract-and-kill control of larvae in storm water catch basins

Invasive plant removal application
Removal of *Lonicera maackii* reduces abundance of mosquitoes and their avian hosts in forest fragments

Acknowledgments

Research Students

Brit'nee Haskins, Lauren Frisbie, Matt Edinger, Jackie Duple, Noor Malik, Leah Overmier, Katie Lincoln, Chase Robinson, Reanna Kayser, Michelle Manious, Audrey Killarney, Kristen Chen, Alexandra Braet, Jake Gold, Billy LeGare, Brian Fitzsimmons, Grace Cahill

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Allison Parker, Northern Kentucky U
Tanya Josek, Illinois State University