CENTRE DE LA SCIENCE DE LA BIODIVERSITÉ DU QUÉBEC
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Impacts of introduced predatory fishes in Ontario lakes

Assessing the roles of evolutionary naiveté and predator richness

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What are the impacts of predator introductions?

Potential Impacts

-replacement of native predators

-increased consumption of prey

-extirpations of prey

-increased top-down control

-altered food web structure

-changes in habitat coupling

-ecosystem-level effects

Eby et al. 2006

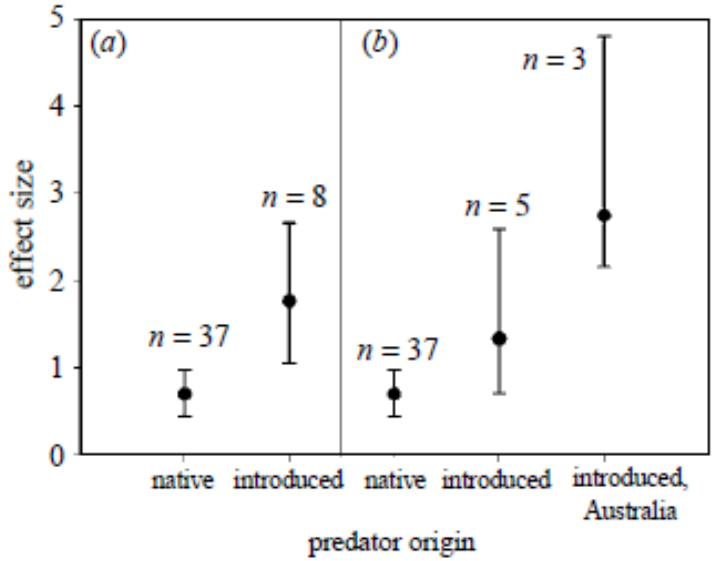
Greatest impacts in isolated habitats (lakes, islands)

Does naiveté play a role in predator impacts?

- Lack of evolutionary experience with predator archetypes
- Large impact of novel predators on naive prey

Introduced predators more dangerous than native predators

(Salo et al. 2007)



Continental USA

Native predators ▸ increased native fish richness

Introduced predators ▸ decreased native fish richness

(Mitchell and Knouft 2009)

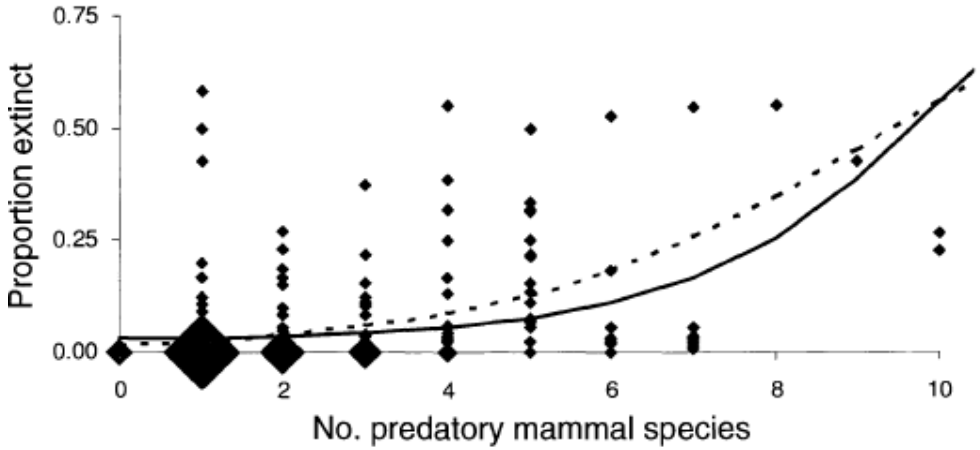
North East USA

No difference in effect of native or introduced littoral predators on native minnow presence

(Whittier et al. 1997)

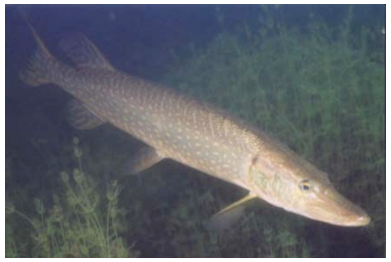
How does impact change with introduced predator richness?

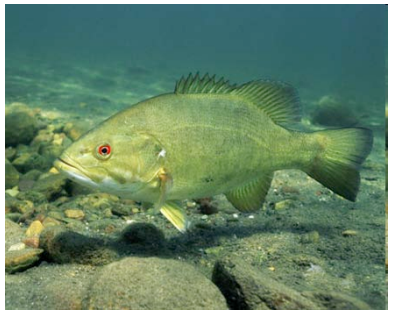
- Resource partitioning, selection effects, interactions between predators?



Facilitation leading to increased extinction of island birds (Blackburn et al. 2005)

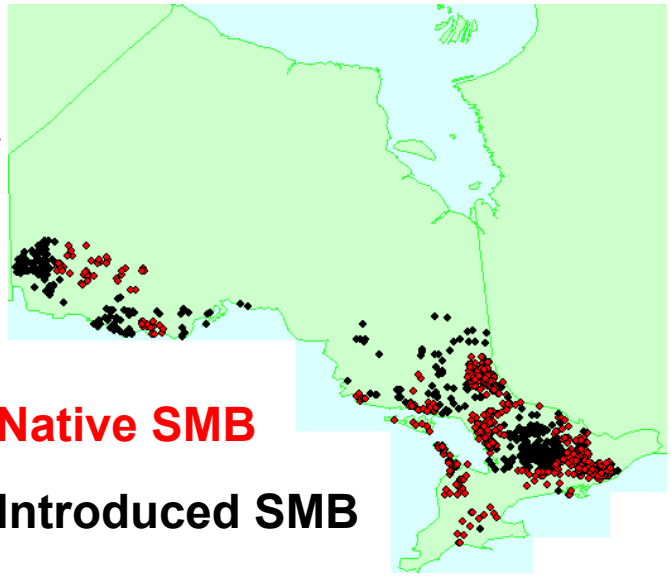
Potential interactions between fish invaders is a key difficulty in predicting introduction outcomes (Leprieur et al. 2009)





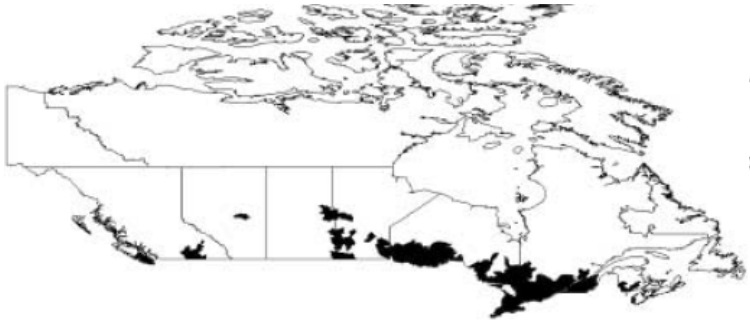
Piscivorous fish introductions in Ontario

- extirpations of competitors and prey
- diet shifts in competitors
- morphological changes in prey
- trophic cascades



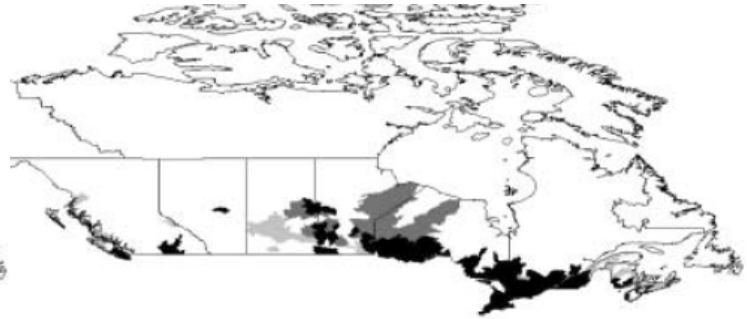
Native SMB

Introduced SMB

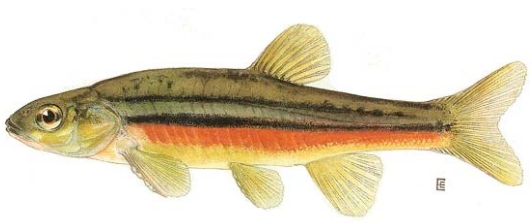


Current smallmouth bass range

Chu et al. 2005



Projected smallmouth bass range in 2050



Cyprinids

- 200+ species in North America
- Sensitive to environmental changes
- Common prey species for many fishes
- Extirpations of cyprinid populations linked with the presence of predatory fishes

  (He and Kitchell 1990, Chapleau et al. 1997, Whittier et al. 1997, Findlay et al. 2000, Jackson 2002)
- Thousands of populations of cyprinids threatened by climate-change related predatory fish range expansions

  (Jackson and Mandrak 2002)

Hypotheses:

1) **Predator presence:** Lakes with any predator(s) will have fewer cyprinid species than lakes with no predator(s).

2) **Naiveté:** Lakes with introduced smallmouth bass will have fewer cyprinid species than lakes with native smallmouth bass.

3) **Predator richness:** Fewer cyprinid species as predator richness increases.

Datasets:

Ontario Aquatic Habitat Inventory (~10 000 lakes)

Fish species distributions + physical and chemical variables

Undersampling of small fishes

Atlas of Smallmouth Bass Lakes in Ontario (~2400 lakes)

Origin status of smallmouth bass populations

Statistical approach

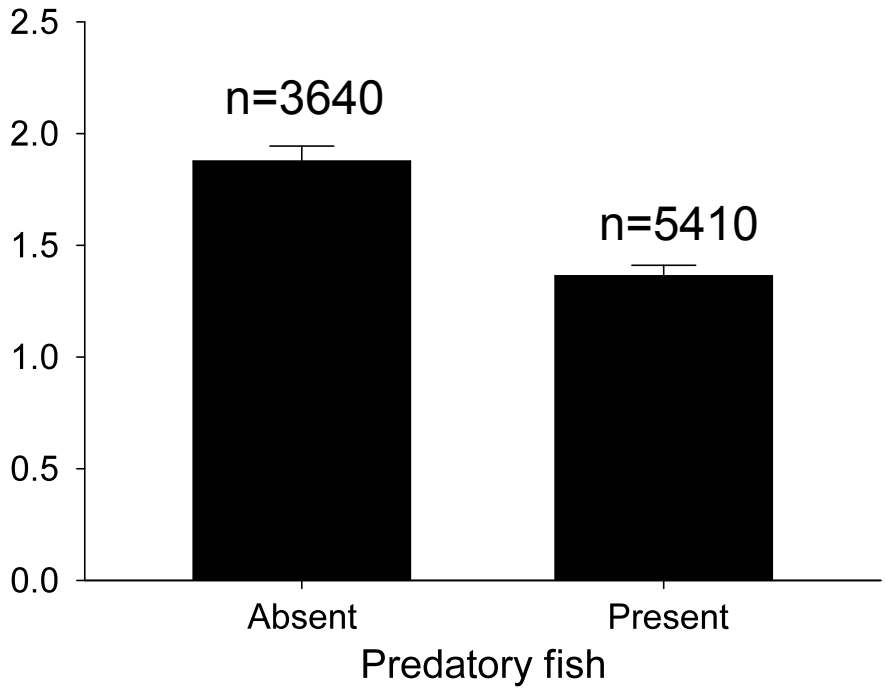
Potential covariates

elevation
distance from glacial lake
distance from ice edge
latitude
pH
secchi
TDS
area
mean depth
maximum depth
perimeter
shoreline development factor
anthropogenic development

- Stepwise regression to reduce number of covariates

- Zero-inflated negative binomial regression to test effect of predator variables controlling for covariates

Results: Predator presence



Consistent with a number of studies from other systems

Predator-specific variation in impact on cyprinid richness

Smallmouth bass (n=420)

Largemouth bass (n=118)

Walleye (n=107)

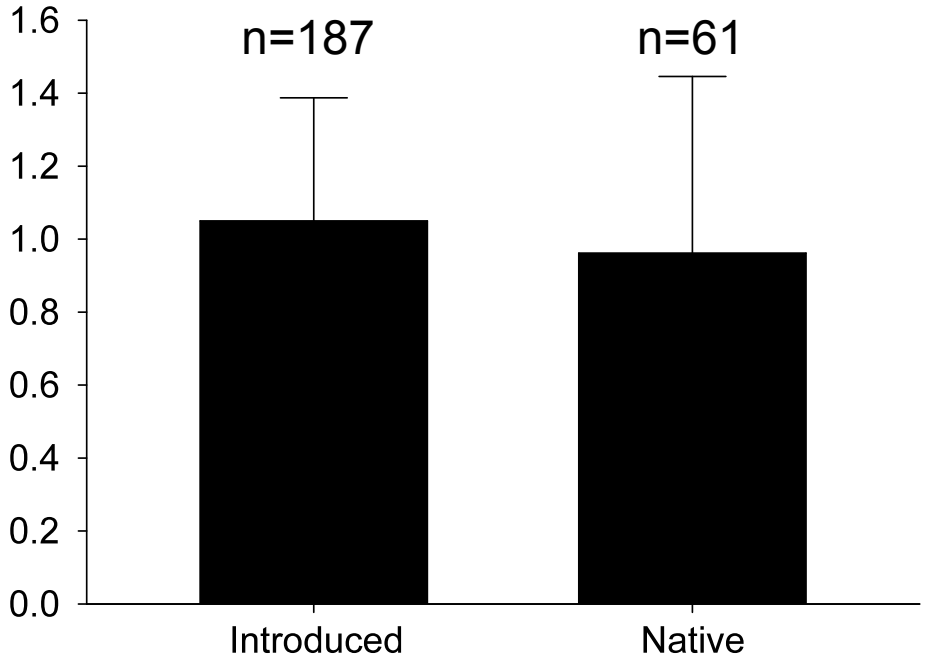
Northern pike (n=1456)

Rock bass (n=164)

vs. lakes with none (n=3640)

- Fewer cyprinids ($p<0.05$)
- Fewer cyprinids ($p<0.05$)
- Fewer cyprinids (NS)
- Fewer cyprinids ($p<0.05$)
- Fewer cyprinids (NS)

Results: Naiveté to smallmouth bass



(excluding lakes with pike, largemouth bass, rock bass, walleye)

Some cyprinid species are not adapted to co-exist with large-bodied littoral predators such as smallmouth bass

The length of time fish communities have been isolated in naturally predator-free lakes was insufficient for the evolution of naiveté which would cause extirpations of more species following predator introduction than in lakes with native predators

Results: Predator richness

1 predator (n=2265)	vs. lakes with none (n=3640)	▸ Fewer cyprinids (p<0.05)
2 predators (n=2150)		▸ Fewer cyprinids (p<0.05)
3 predators (n=633)		▸ Fewer cyprinids (NS)
4 predators (n=277)		▸ Fewer cyprinids (NS)
5 predators (n=85)		▸ Fewer cyprinids (NS)

Lakes with 2,3,4,5 predators	vs. lakes with one less predator	▸ More cyprinids (p<0.05) or no significant change

Adding predators and comparing to a subset of those predators (38 comparisons), found :

-1 case of significant decrease in cyprinid richness

-5 cases of significant increase in cyprinid richness

-of non-significant changes, 15 had negative trend, 17 had positive trend

Results: Predator Richness

Predators constrain cyprinid richness

Little overall pattern to predator richness effects

Little evidence for increased impact with increased predator richness

Similar findings from other studies

Antagonistic interactions between predators: intraguild predation or interference competition?

Limitations

Uncontrolled variables?

lake characteristic favouring both predators and prey?

no measure of predator or prey densities

Origin status of predators other than smallmouth bass are unknown

Undersampling of cyprinids

Testing hypotheses with field sampling

Sampled nearshore fish communities with multiple gear types

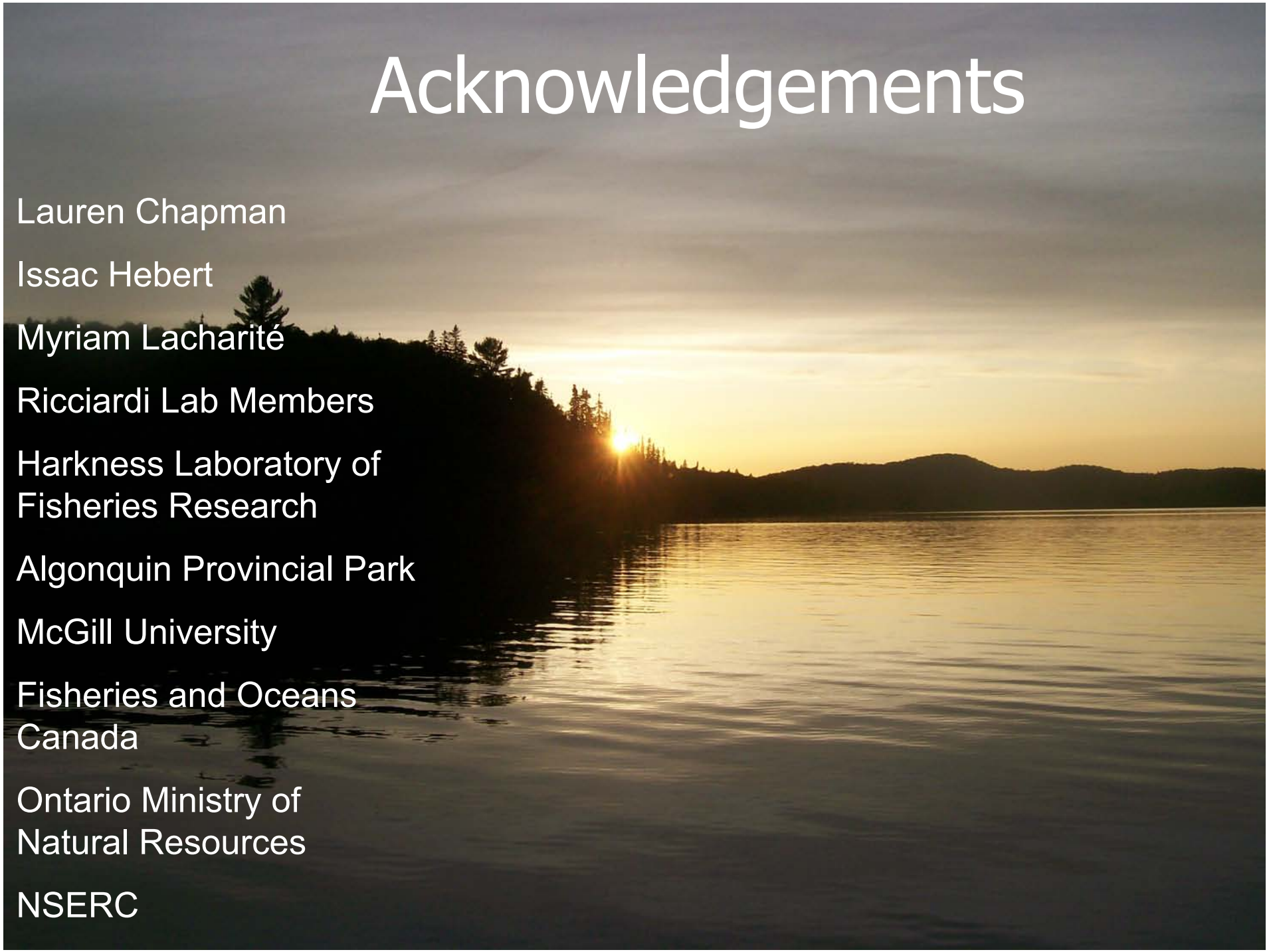
(1) compared fish communities in lakes with and without predators

(2) compared fish communities in lakes with varying numbers of predators

(3) compared fish communities over time with increases in predator richness

Found a clear difference in fish communities in lakes with and without predators

No systematic difference in lakes with one predator and multiple predator species across space or time



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