

The Effects of Road Culverts on Nekton in New England Salt Marshes: Implications for Tidal Restoration



Alyson L. Eberhardt

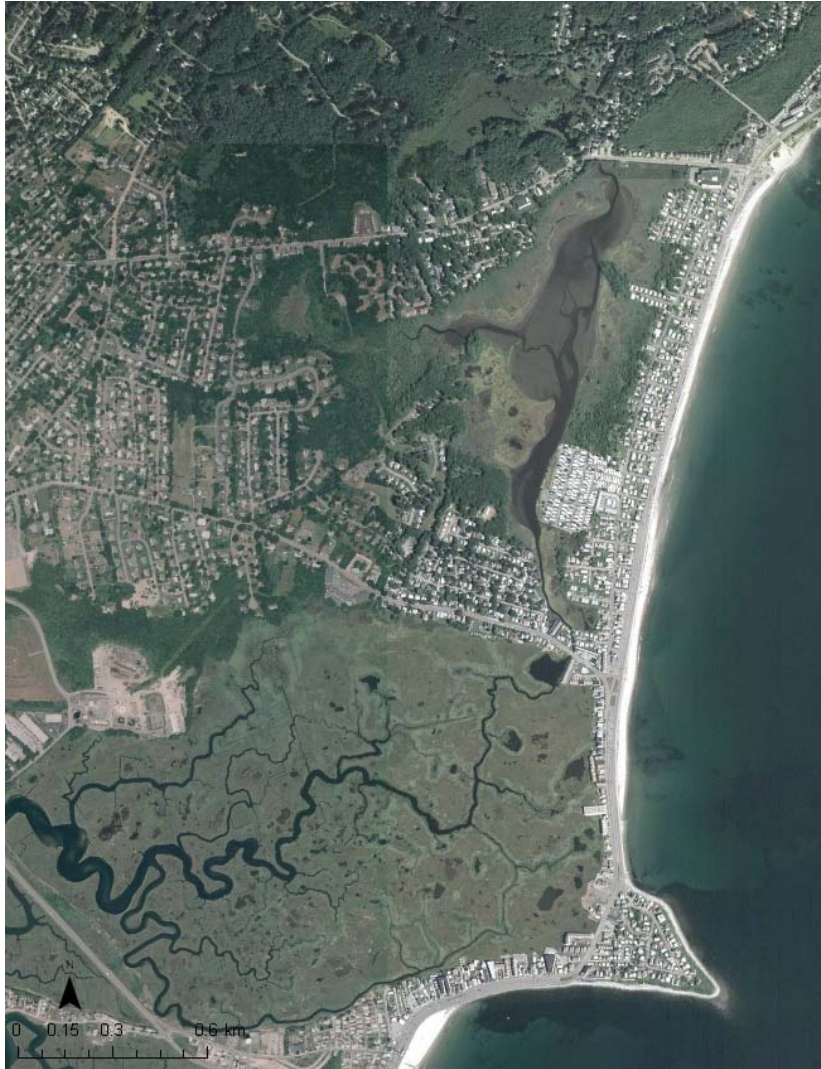
David M. Burdick

University of New Hampshire

Michele Dionne

Wells National Estuarine Research Reserve

COASTAL HABITAT IMPACTS



IMPACTS OF RESTRICTED HYDROLOGY



- Decreased salinity
(Roman et al. 1984; Burdick et al. 1999)
- Colonization by invasive vegetation
(Roman et al. 1984; Burdick et al. 1999)
- Changes to infaunal communities
(Fell et al. 1991)
- Reduced habitat access and use by nekton
(Able and Hagan 2000, Roman and Raposa 2001, Raposa and Roman 2003)



BENEFITS OF TIDAL RESTORATION



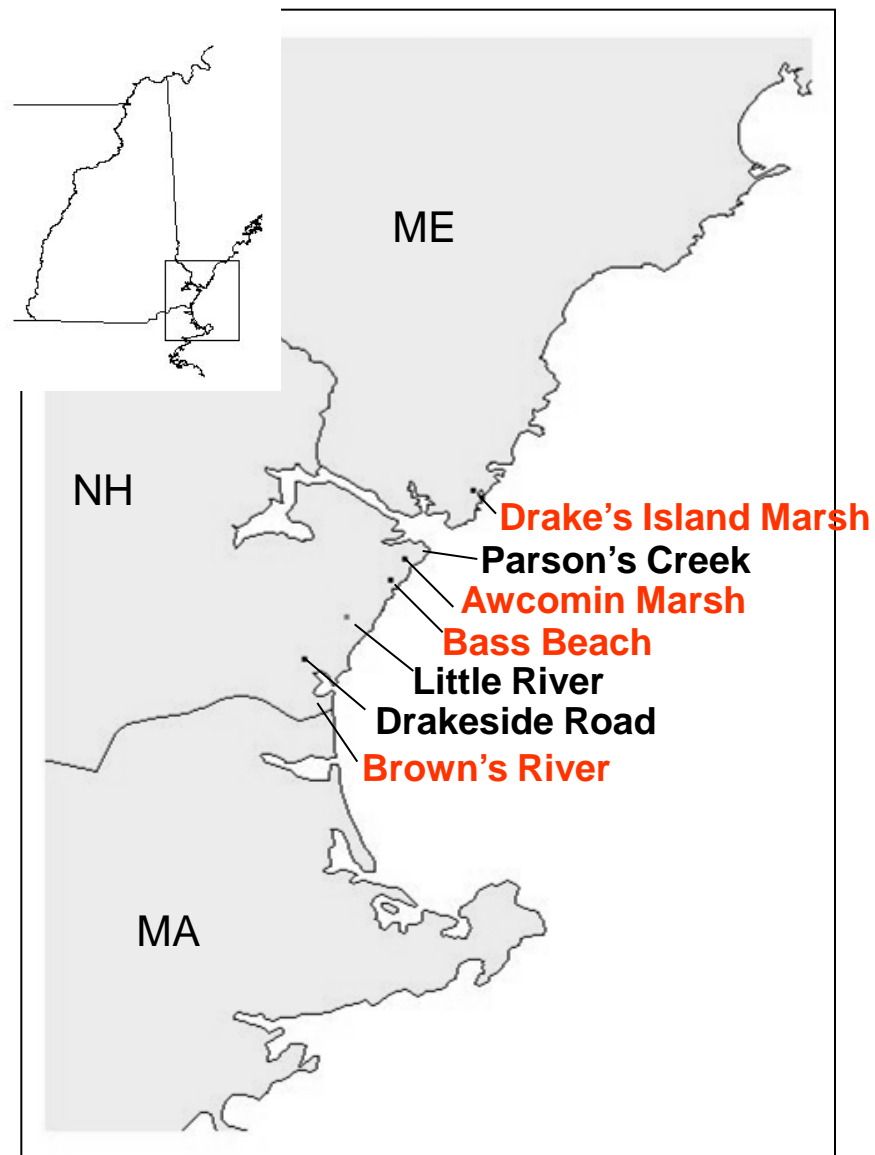
- Reestablishment of salt marsh vegetation
(e.g. Roman et al. 1984, Barrett and Neiring 1993, Burdick et al. 1997)
- Increased soil salinity
(Beefink 1979, Sincrope et al. 1990, Burdick et al. 1997)
- Colonization by macroinvertebrate and avifauna communities
(Peck et al. 1994, Brawley et al. 1998)
- Restored habitat use by nekton
(Dionne et al. 1999, Roman et al. 2002, Roman and Raposa 2003, Teo and Able 2003)

OBJECTIVES

- ➔ 1. Determine the effect of culverts on upstream nekton assemblages
- 2. Determine if culverts restrict the movements of the mummichog, *Fundulus heteroclitus*

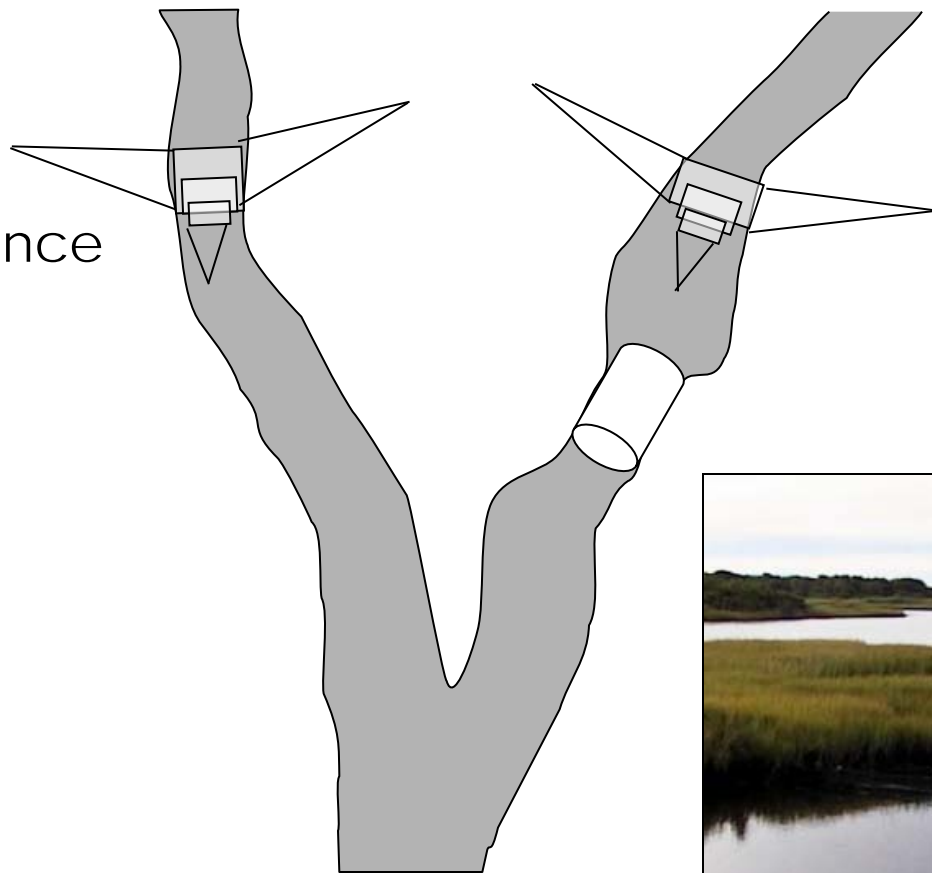


FYKE NET SAMPLING SITES



FYKE NET SAMPLING DESIGN

Reference



Culvert

- restricted
- restored



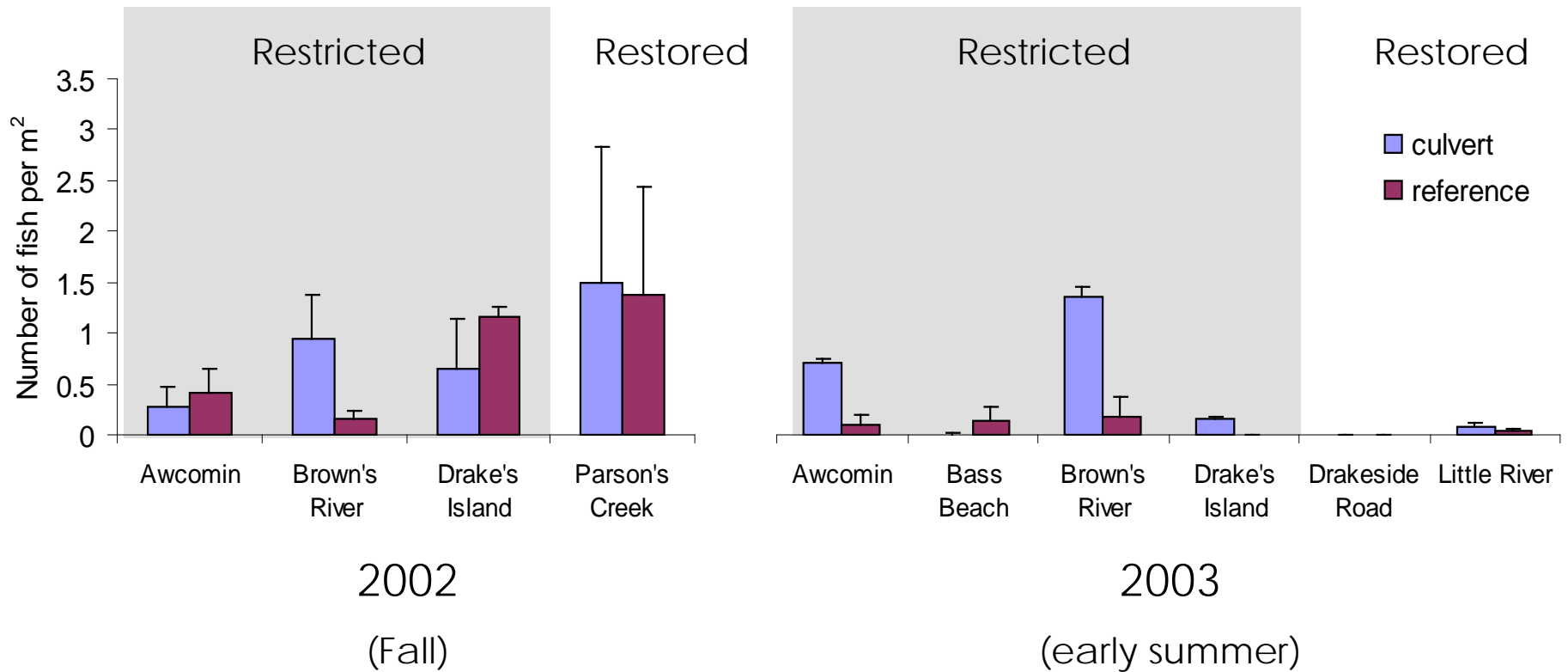
RESULTS - NEKTON COMMUNITY

Contribution of each species to the total nekton community

Species	Common Name	Reference (%)		Restored (%)		Restricted (%)	
		2002	2003	2002	2003	2002	2003
<i>Alosa aestivalis</i>	Blueback herring	—	5%	—	—	—	—
<i>Anguilla rostrata</i>	American eel	<1%	<1%	<1%	<1%	<1%	<1%
<i>Brevoortia tyrannus</i>	Atlantic menhaden	2%	—	—	—	—	—
<i>Carcinus maenas</i>	Green crab	10%	16%	1%	49%	12%	7%
<i>Crangon septemspinosa</i>	Sand shrimp	—	26%	—	3%	—	16%
<i>Cyprinodon variegatus</i>	Sheepshead minnow	<1%	<1%	—	—	—	<1%
<i>Fundulus heteroclitus</i>	Mummichog	77%	32%	98%	46%	86%	71%
<i>Fundulus majalis</i>	Striped killifish	<1%	<1%	<1%	—	<1%	—
<i>Hemigrapsus sanguineus</i>	Asian shore crab	—	<1%	—	—	—	—
<i>Gasterosteus aculeatus</i>	Threespine stickleback	—	<1%	—	—	<1%	<1%
<i>Menidia menidia</i>	Atlantic silverside	9%	<1%	—	—	—	<1%
<i>Mugil curema</i>	White mullet	<1%	—	—	—	<1%	—
<i>Palaemonetes pugio</i>	Daggerblade grass shrimp	1%	20%	—	3%	2%	<1%
<i>Peprilus triacanthus</i>	Butterfish	—	—	—	—	<1%	—
<i>Pungitius pungitius</i>	Ninespine stickleback	—	<1%	—	<1%	<1%	5%
<i>Pseudopleuronectes americanus</i>	Winter flounder	<1%	—	—	—	—	—
Total number of species		10	12	4	6	9	9

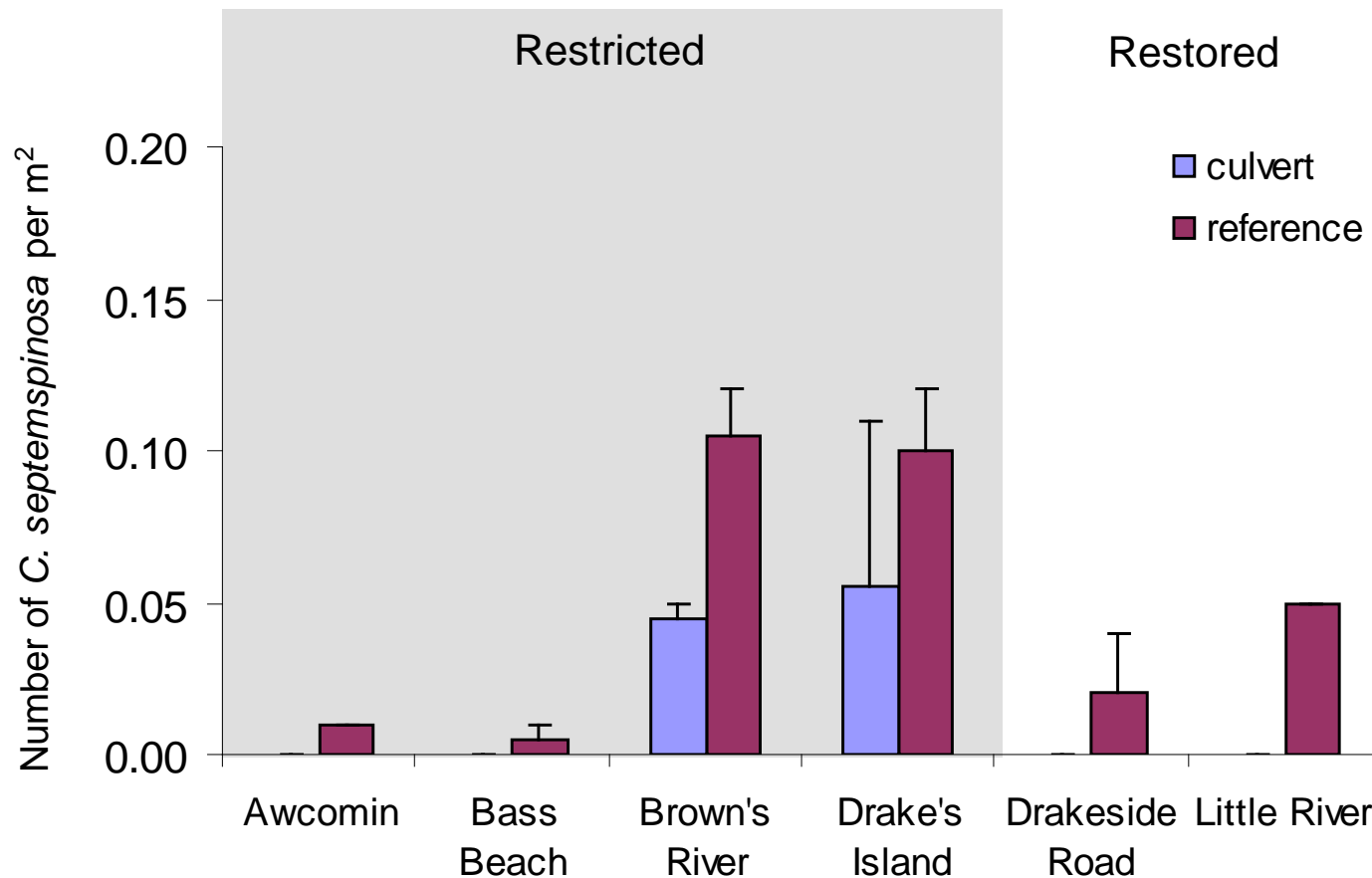
	p value
<i>Test for differences among sites</i>	0.001
<i>Pairwise comparisons between hydrology</i>	
restricted versus reference	1.000
restricted versus restored	0.333
reference versus restored	0.920

RESULTS - FISH DENSITY



(Repeated measures ANOVA)	2002	2003
Culvert presence/absence	F=0.045; p<0.844	F=1.67; p<0.253
Hydrology (restricted or restored)	F=0.009; p<0.935	F=0.720; p<0.444

RESULTS - *CRANGON SEPTEMSPINOSA* DENSITY



(Repeated measures ANOVA)

	2003
Culvert presence/absence	F=11.4; p<0.020

CONCLUSIONS - DRAKE'S ISLAND MARSH



Photo: <http://maps.google.com>; 2 Nov 2010

CONCLUSIONS - FYKE NET SAMPLING



Fish communities upstream of tidally restricted and restored culverts are similar to communities in reference systems



Culverts may inhibit sand shrimp (*Crangon septemspinosa*) access to upstream areas



Ponds upstream of undersized culverts may retain fish at all tidal stages, deterring downstream movement.

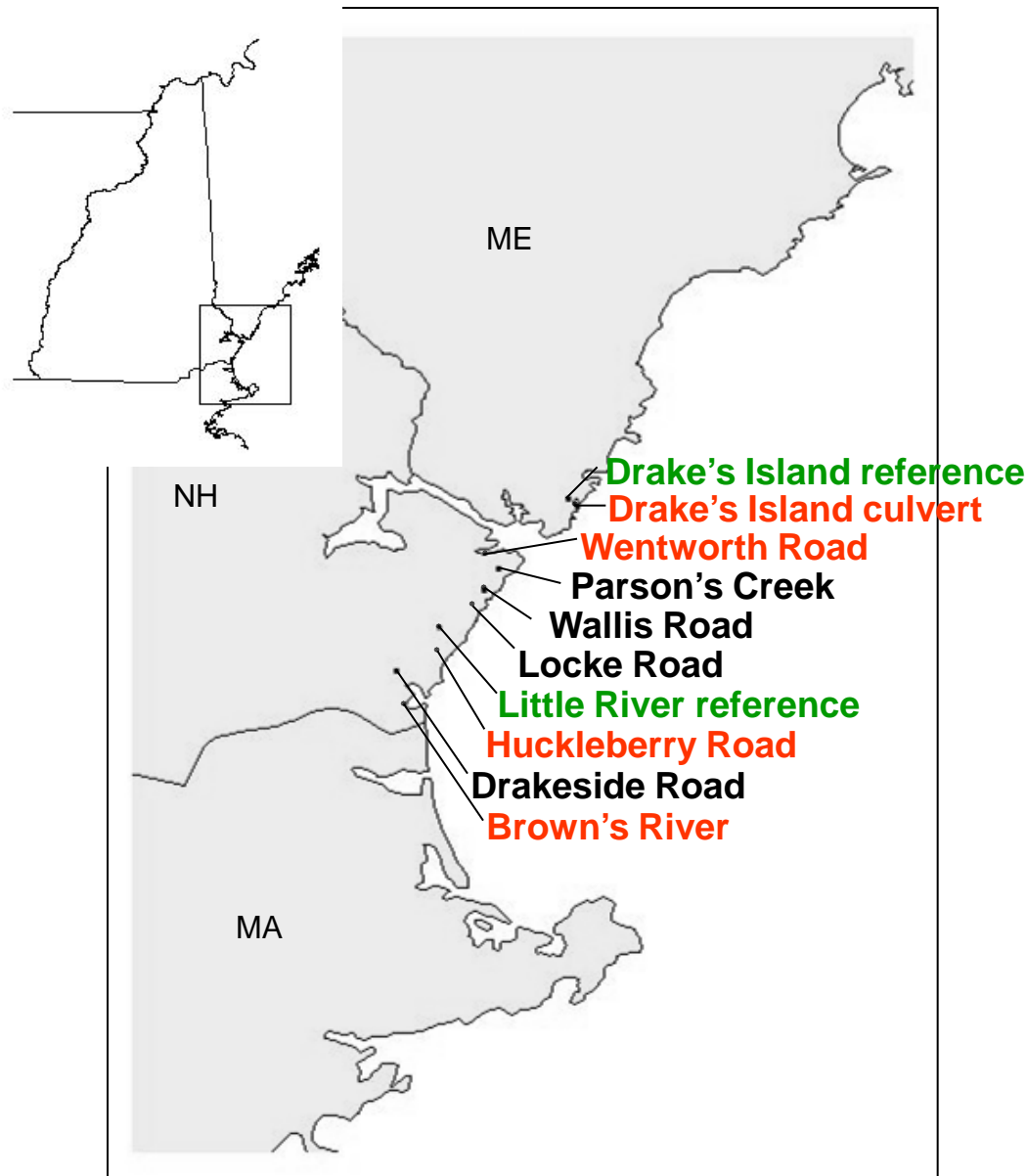
OBJECTIVES

1. Determine the effect of culverts on upstream nekton communities

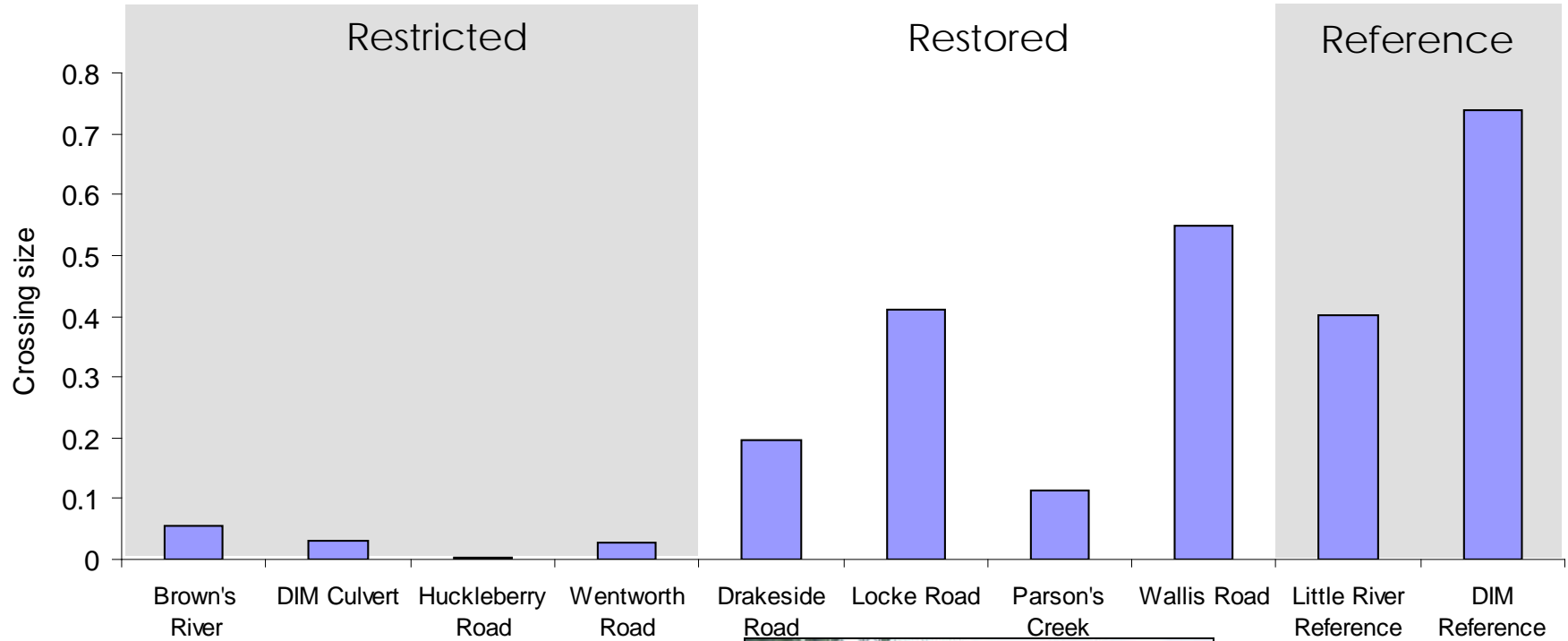
→ 2. Determine if culverts restrict the movements of the mummichog, *Fundulus heteroclitus*



MARK RECAPTURE SAMPLING SITES



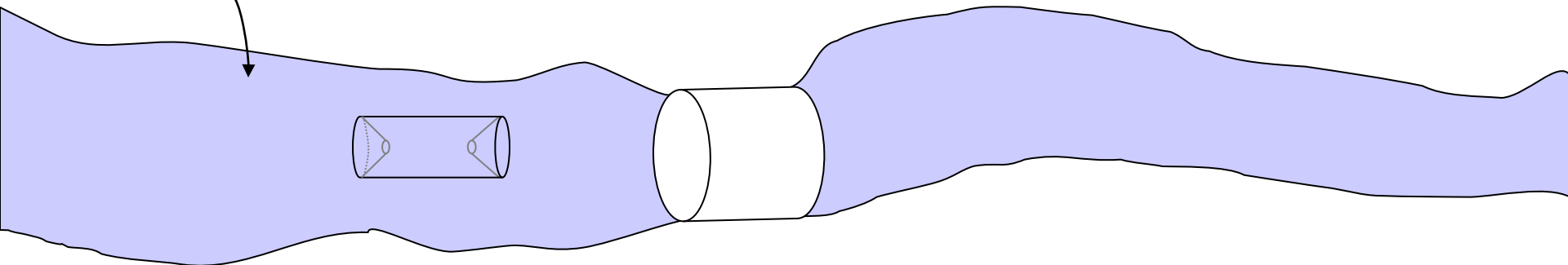
CROSSING SIZE



FISH PASSAGE

Capture

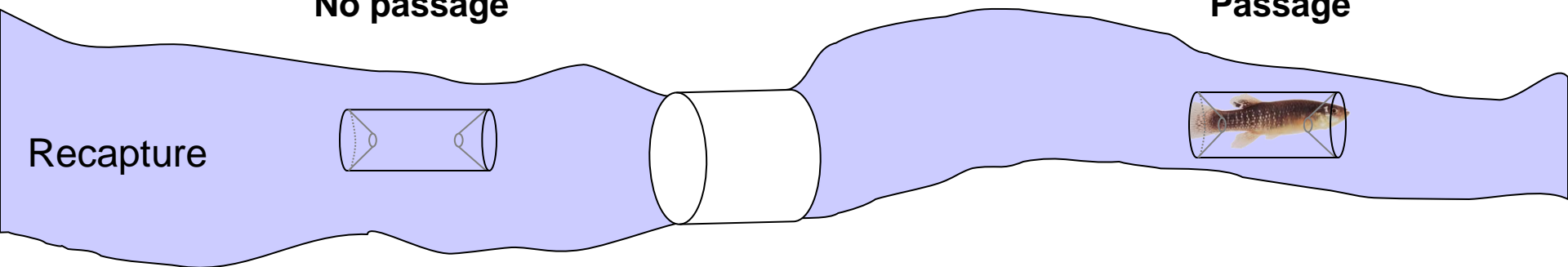
Release



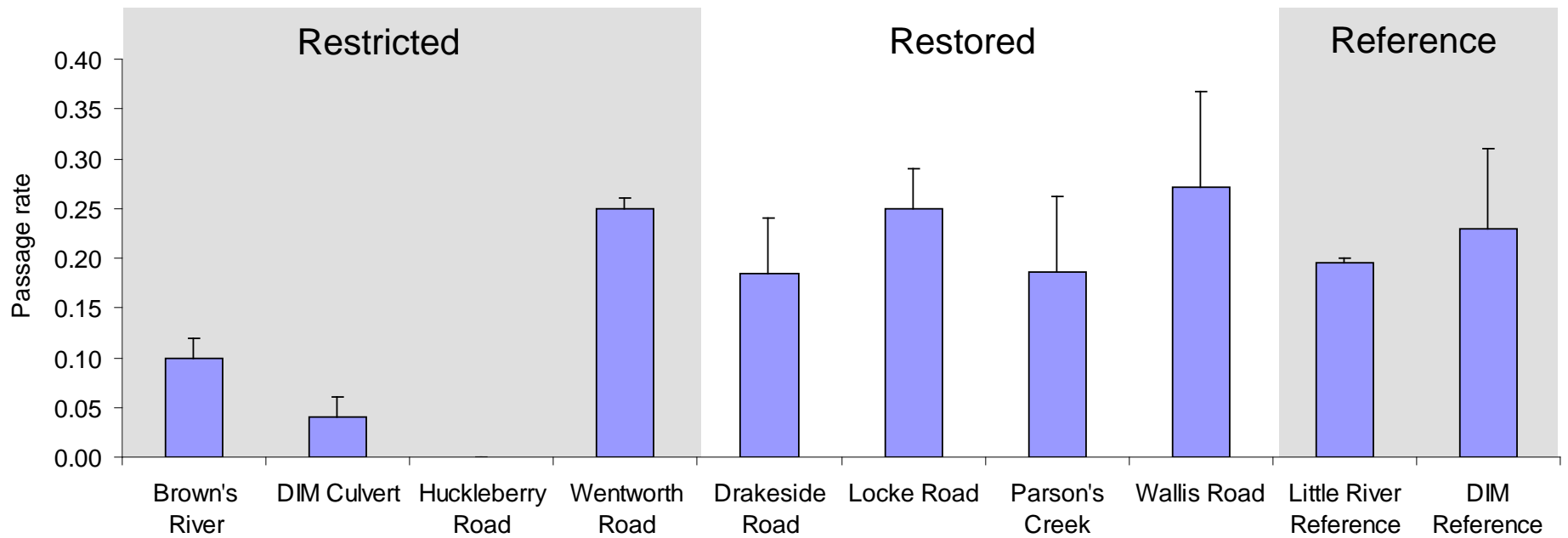
No passage

Passage

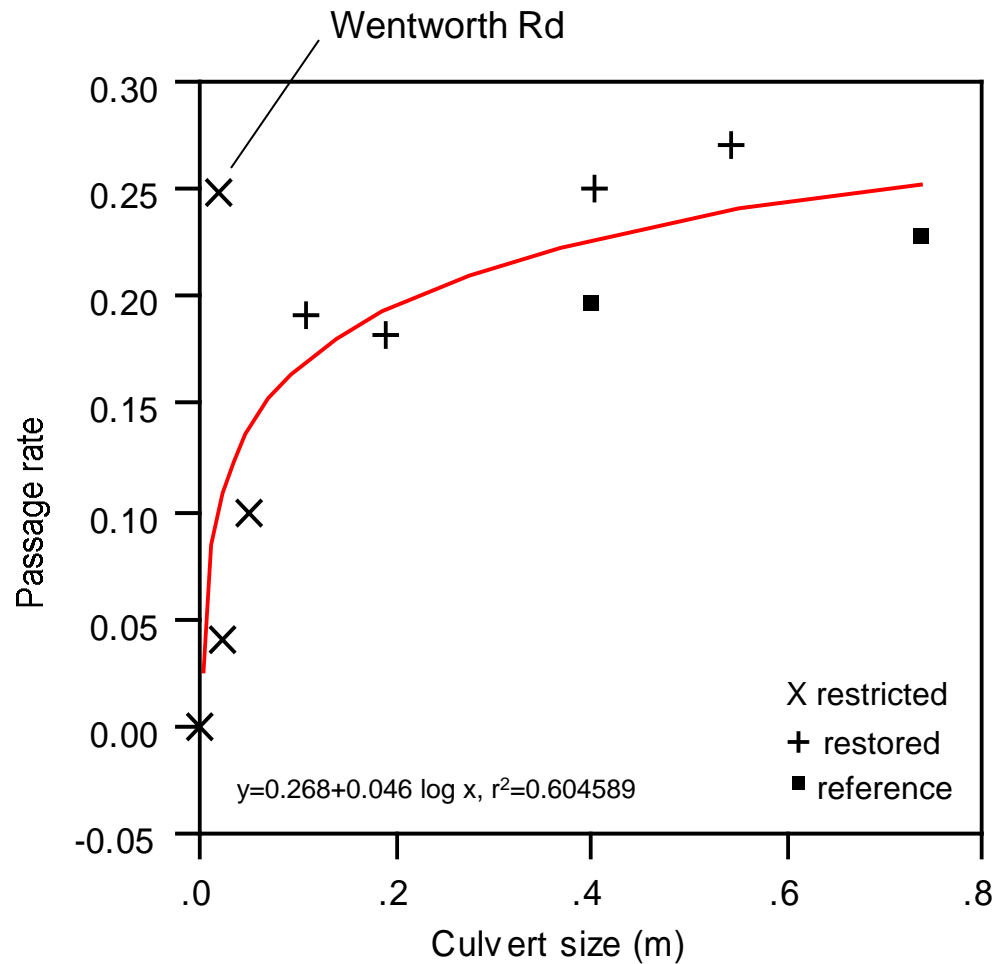
Recapture



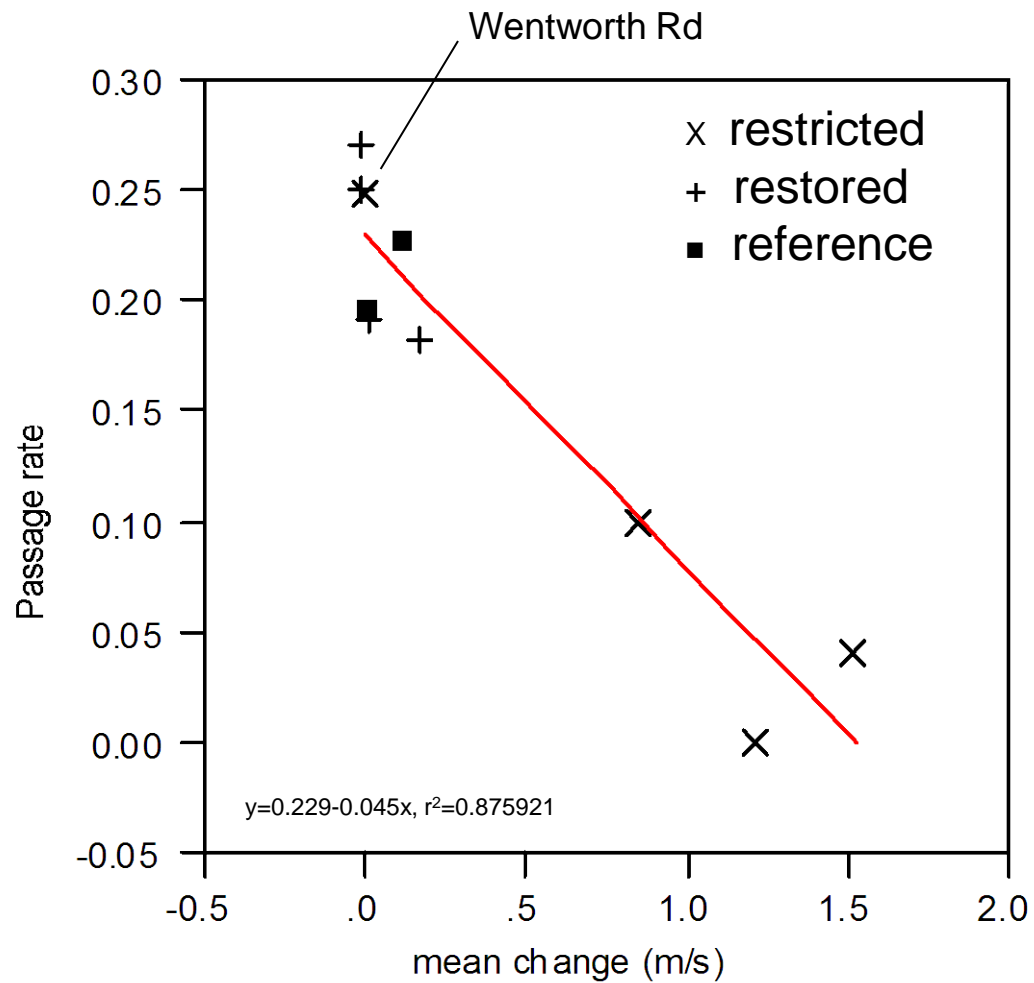
RESULTS - FISH PASSAGE



RESULTS - FISH PASSAGE



RESULTS - FISH PASSAGE



MARK-RECAPTURE CONCLUSIONS

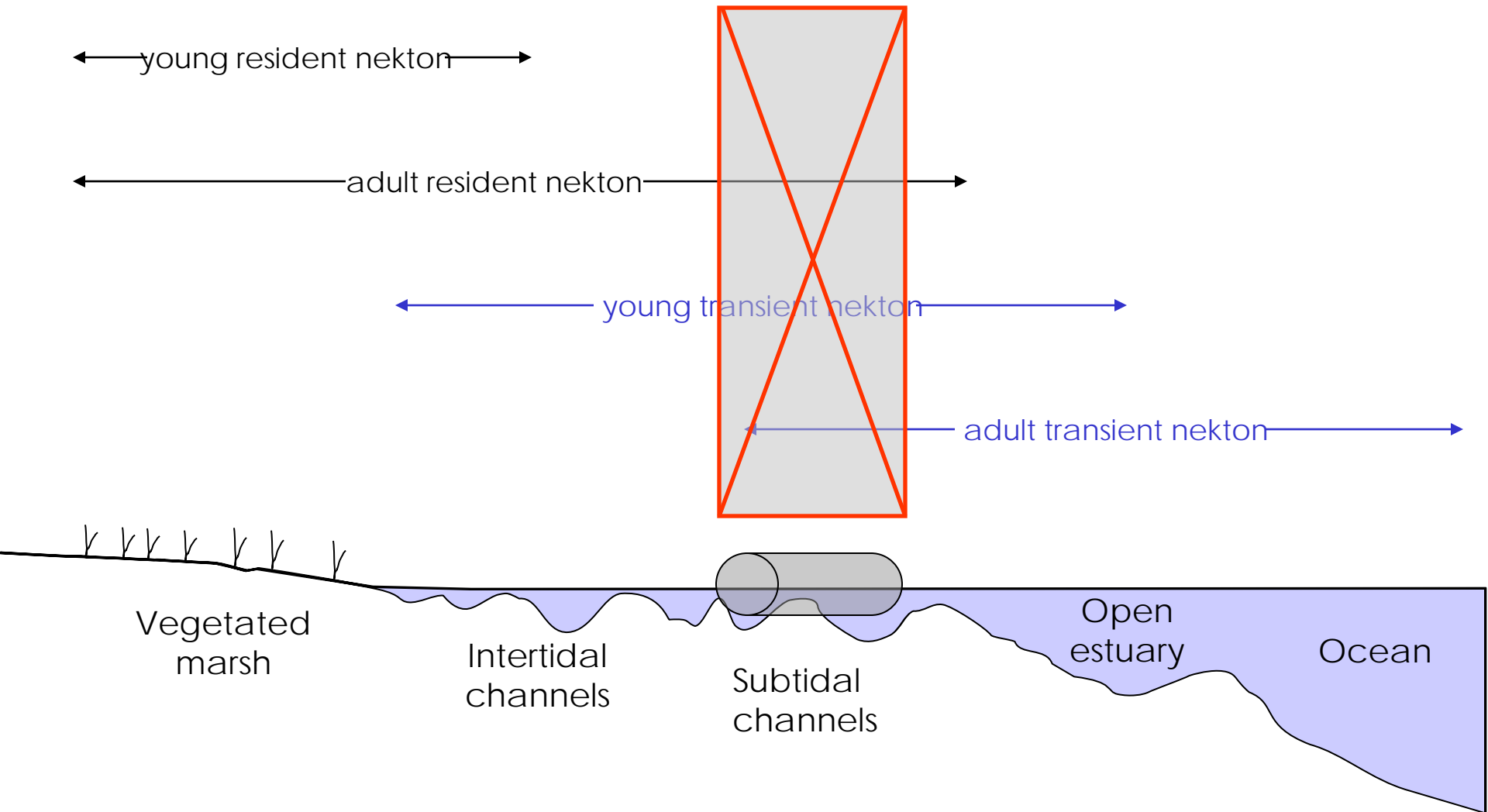


Increasing the size of tidally restrictive culverts will result in increased passage of *F. heteroclitus*; full hydrologic restoration can increase passage to reference levels.



The accelerated water velocity caused by undersized culverts inhibits the movement of *F. heteroclitus* between upstream and downstream areas.

TROPHIC RELAY MODEL



Adapted from Kneib 1997

CONCLUSIONS



Similar communities measured in upstream areas of tidally restricted, restored and reference marshes indicate that culverts may not prevent fish from reaching upstream areas.



The increased water velocity as well as the presence of upstream subtidal habitats due to undersized culverts may decrease the rate at which nekton move between upstream and downstream areas.



Decreased passage rates may reduce the rate at which marsh derived production is exported out of the system to coastal waters.



ACKNOWLEDGEMENTS



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MARINE PROGRAM

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