



Small-scale effects of shellfish aquaculture on eelgrass

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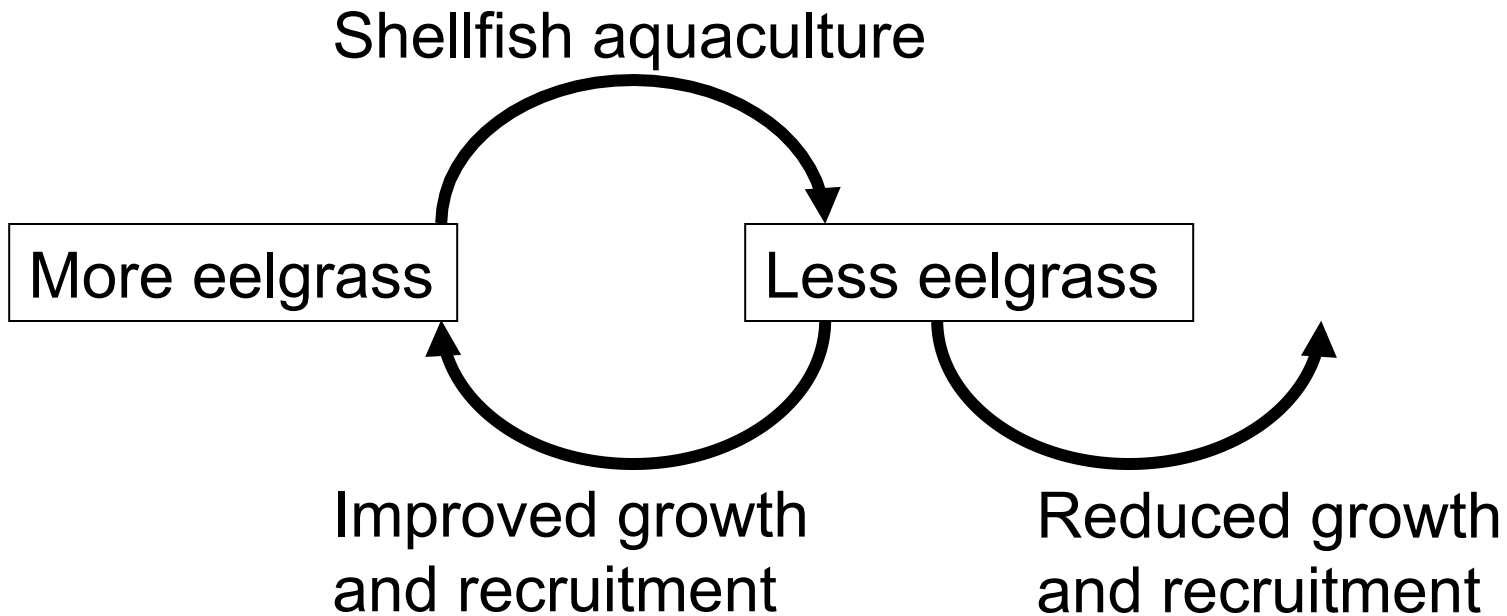
Shellfish aquaculture in *Z. marina*

Method	Site	Density response	Shoot growth response	Recruitment response
Oyster stakes (1)	Coos Bay	-	0	-
Oyster racks (1)	Coos Bay	-		
Oys Longlines (2)	Humboldt Bay	- (spacing-dependent)		
Oys Longlines (3)	Willapa Bay	-		+
On-bottom (3)	Willapa Bay	-		+
Oys Longlines (4)	Willapa Bay	-	0	
On-bottom (4)	Willapa Bay	-	+	
Geoducks (5)	North Bay	- (summer)	0 or +	
Geoducks (6)	Samish Bay	0 or -		

(1) Everett et al. 1995 experiment, (2) Rumrill and Poulton 2004 experiment, (3) Wisheart et al. 2007 observation, (4) Tallis et al. 2009 observation, (5) Ruesink & Rowell 2012 experiment, (6) Horwith in press, observation

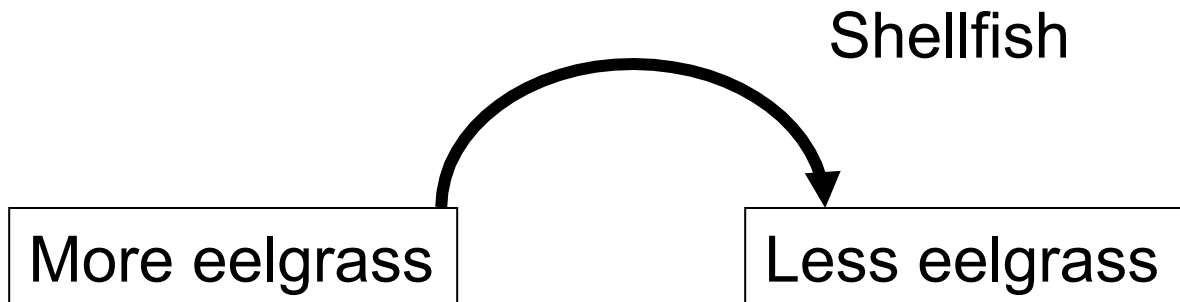
Lesson 1: Shellfish aquaculture generally reduces the local density of *Z. marina*, but –

- 1) Not by the same amount across shellfish species, culture methods, and locations
- 2) Such studies confound effects of disturbance and competition
- 3) Population dynamics may change positively or negatively



Shellfish aquaculture has two aspects of influence

1) Shellfish – compete effectively for space at >10-20% cover

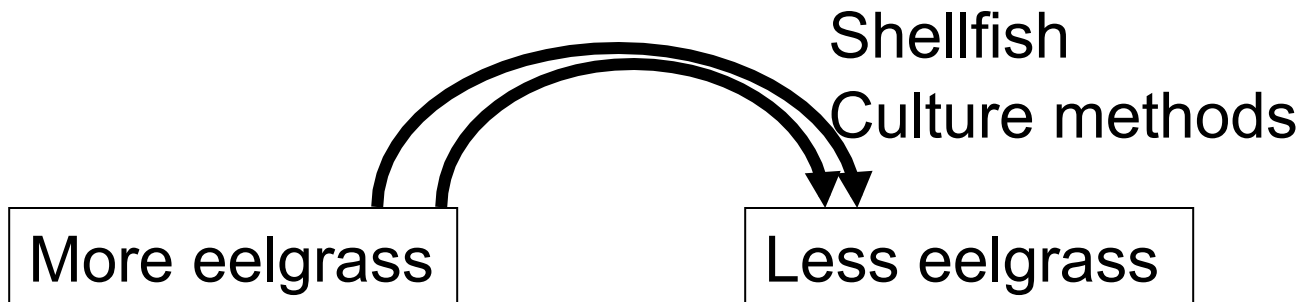


Wagner et al. 2012 experiment, Archer 2008

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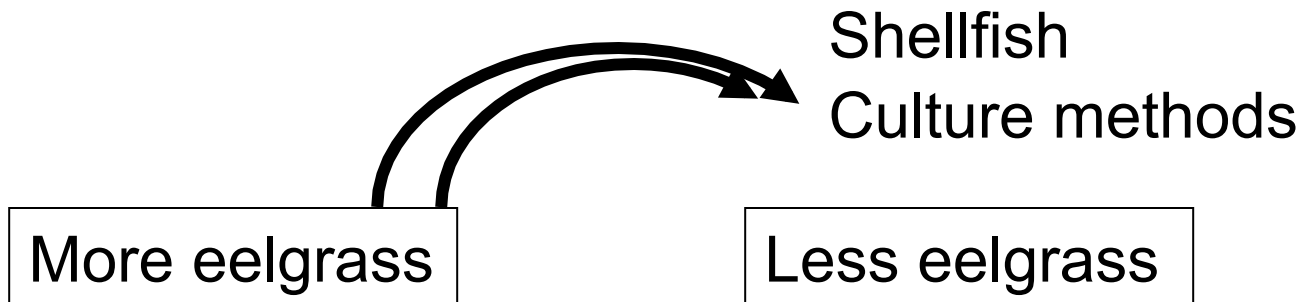
- 1) Shellfish – compete effectively for space at >10-20% cover
- 2) Culture methods

Space competition	Racks, bags, nets, stakes, tubes
Disturbance = removal of biomass	Mechanical harvest, prop scars and wash, desiccation on stakes



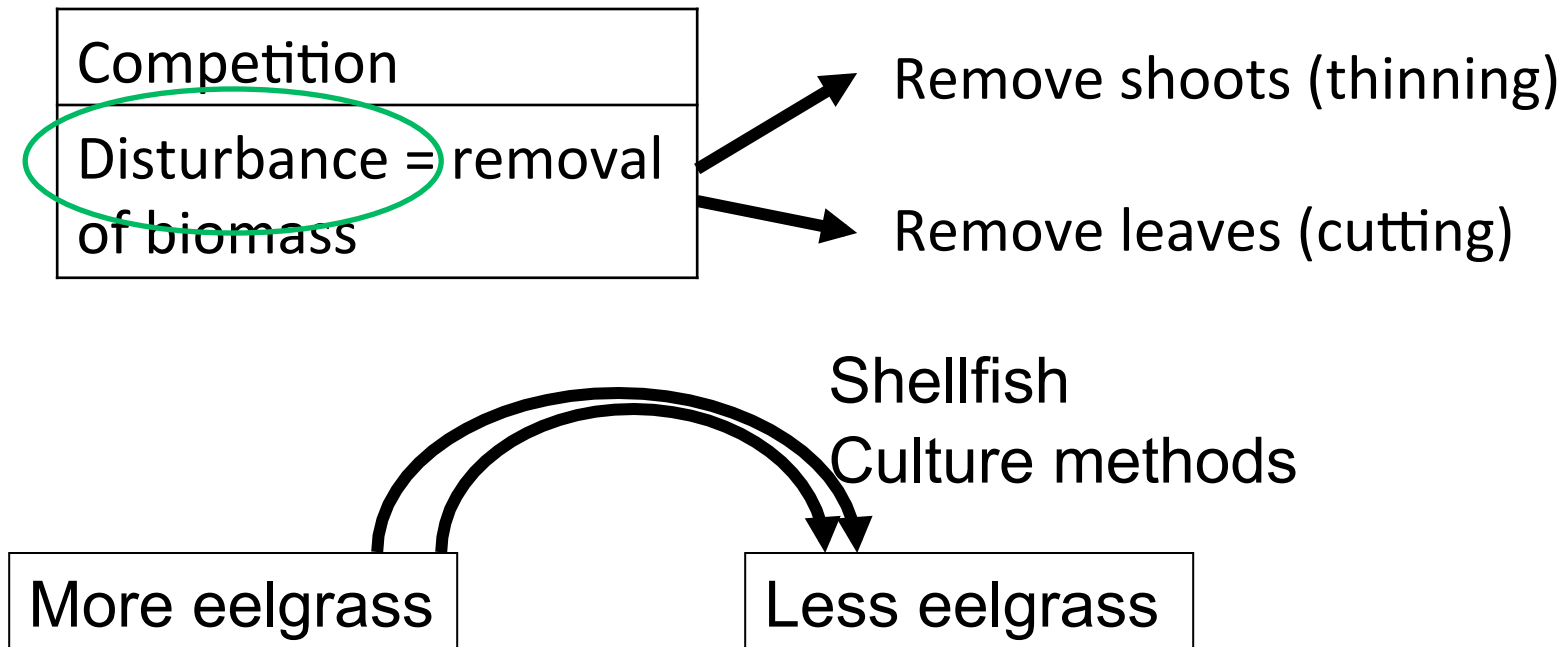
Management responses

- 1) Limit outplant density, e.g. in native oyster restoration
- 2) Limit mechanical harvest, Prescribe longline spacing, e.g. in Humboldt Bay

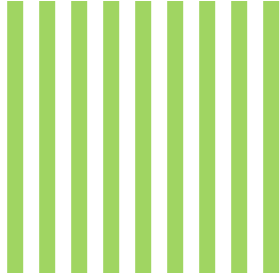


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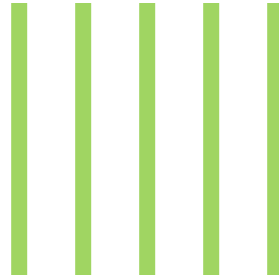
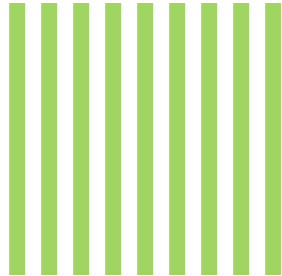
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Experimental test of multiple disturbances

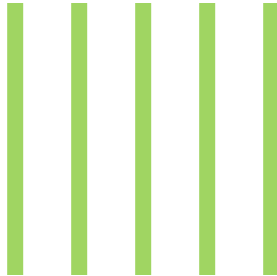
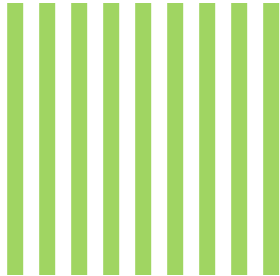


Experimental test of multiple disturbances

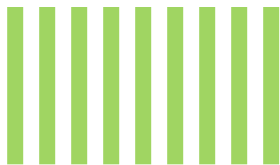


Thinning

Experimental test of multiple disturbances



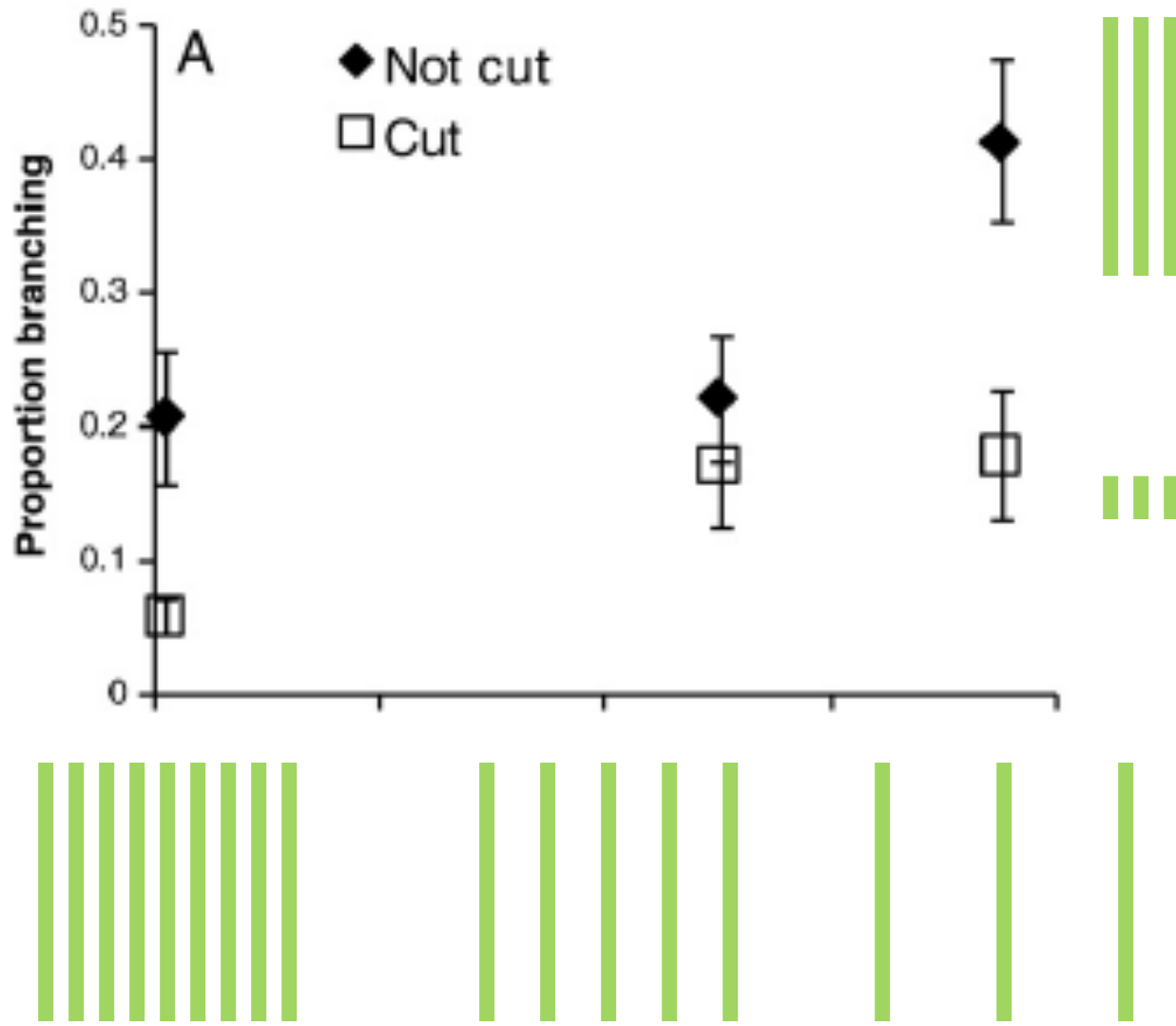
Thinning



Thinning and cutting

Cutting
(1 time or 3 times)

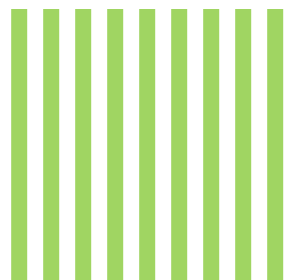
Thinning, but not cutting, accelerates recovery



Thinning, but not cutting, accelerates recovery

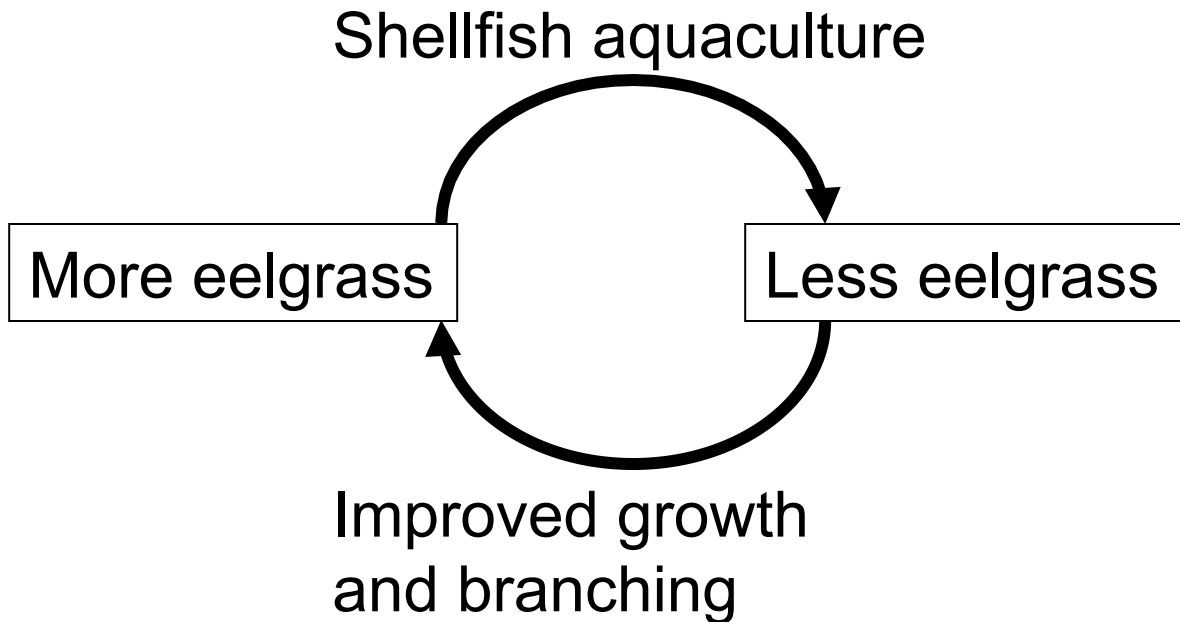


In Samish Bay, high mortality followed cutting



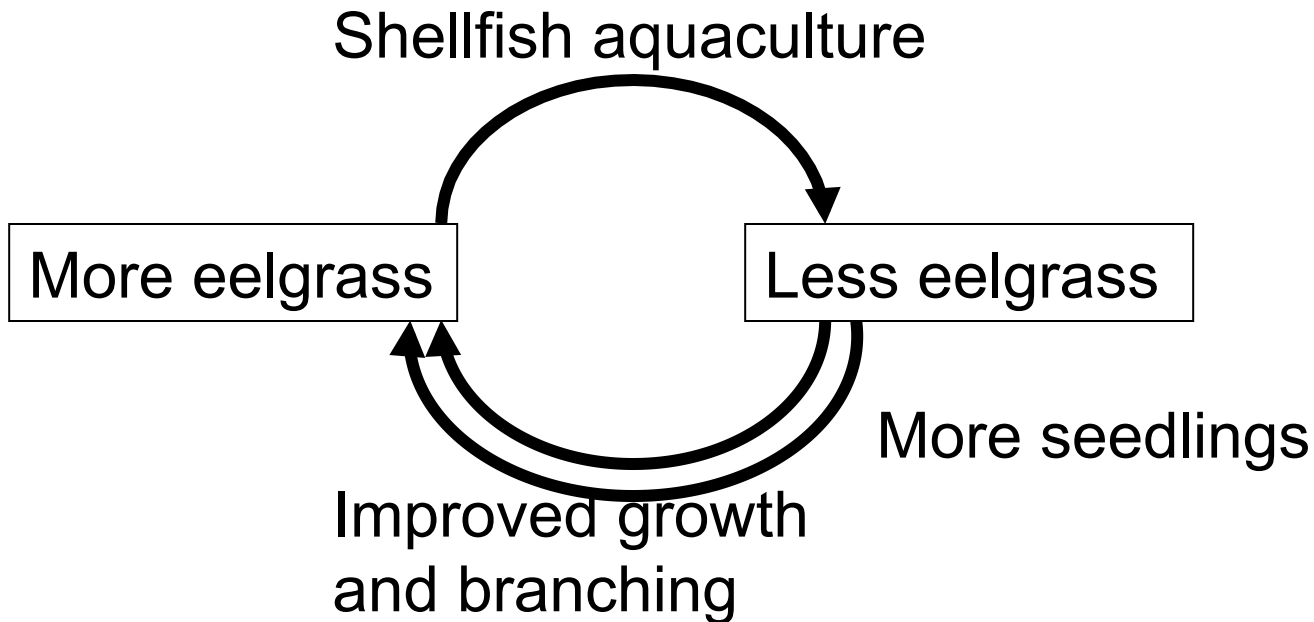
Lesson 2: *Z. marina* is resilient if some shoots remain and resource availability improves

- 1) Light, nutrients more available
- 2) No deterioration in sediment, water clarity, hydrodynamic energy, or desiccation
- 3) Disturbance return time exceeds recovery time



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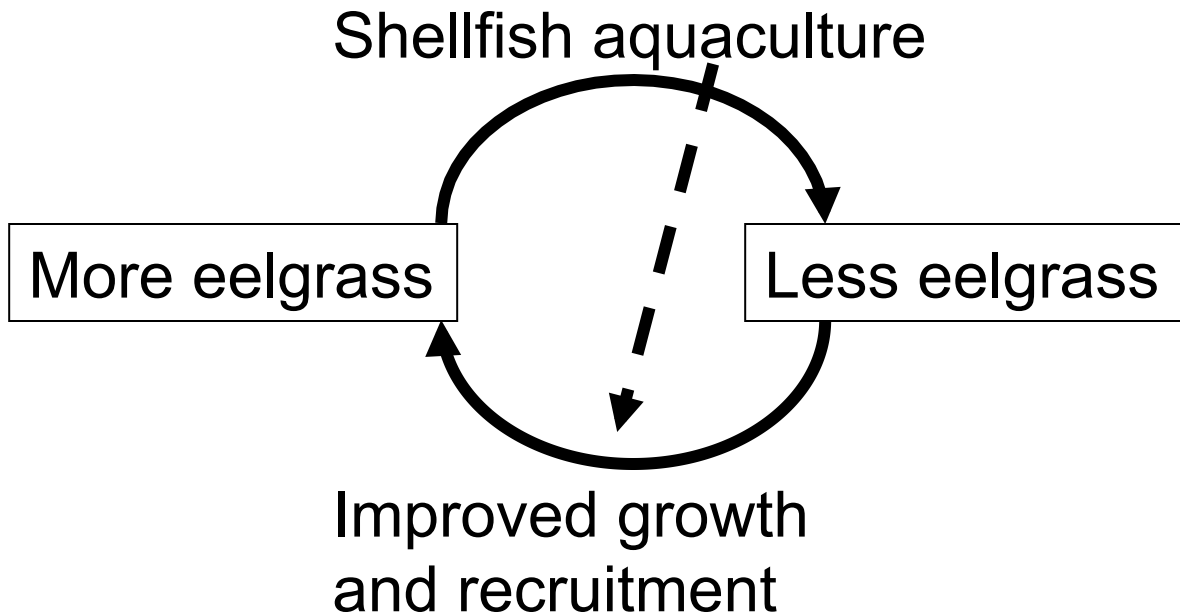
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Shellfish aquaculture can help some environmental conditions for *Z. marina*

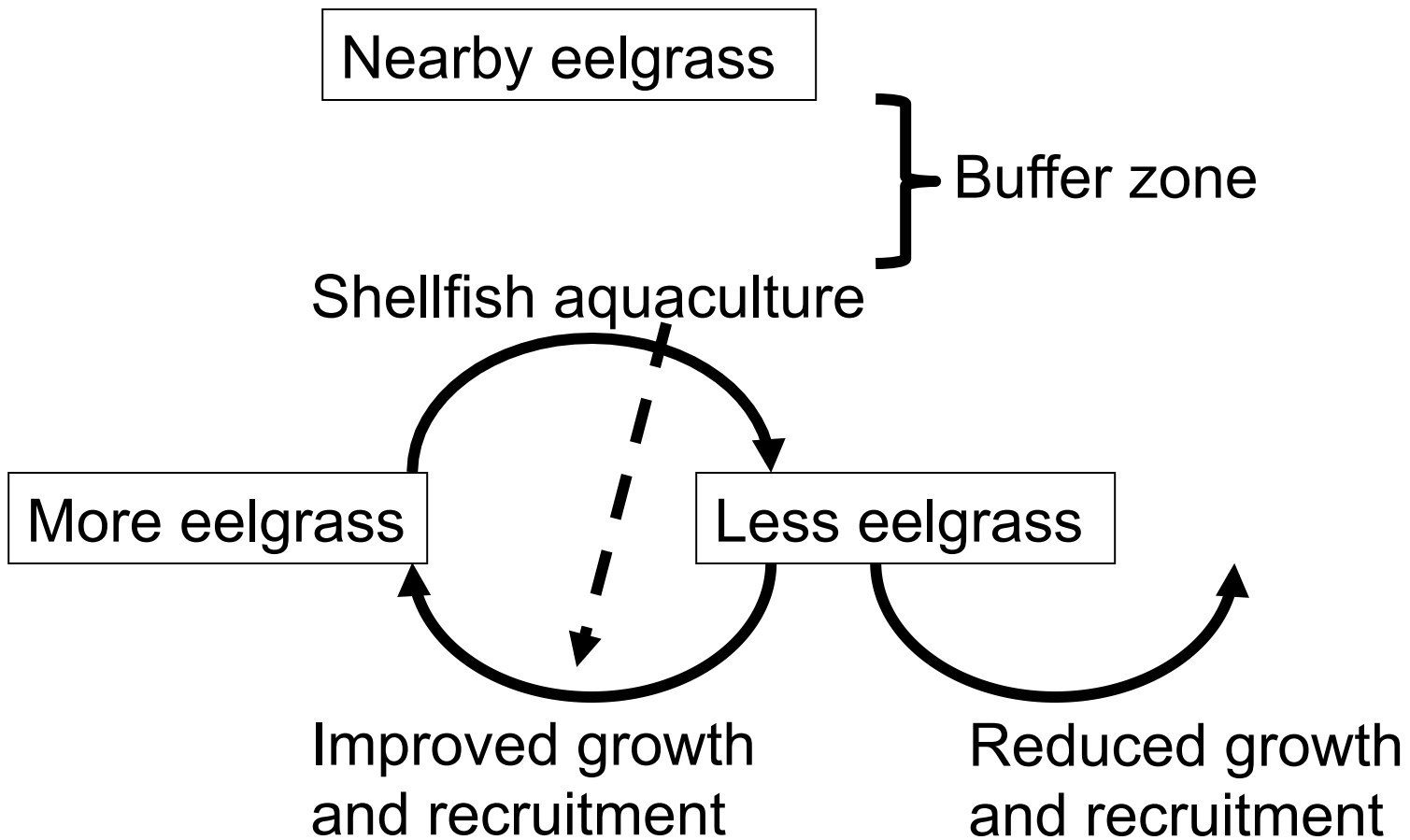
Light – possible due to water filtration

Sediment stabilization – not improved by tubes

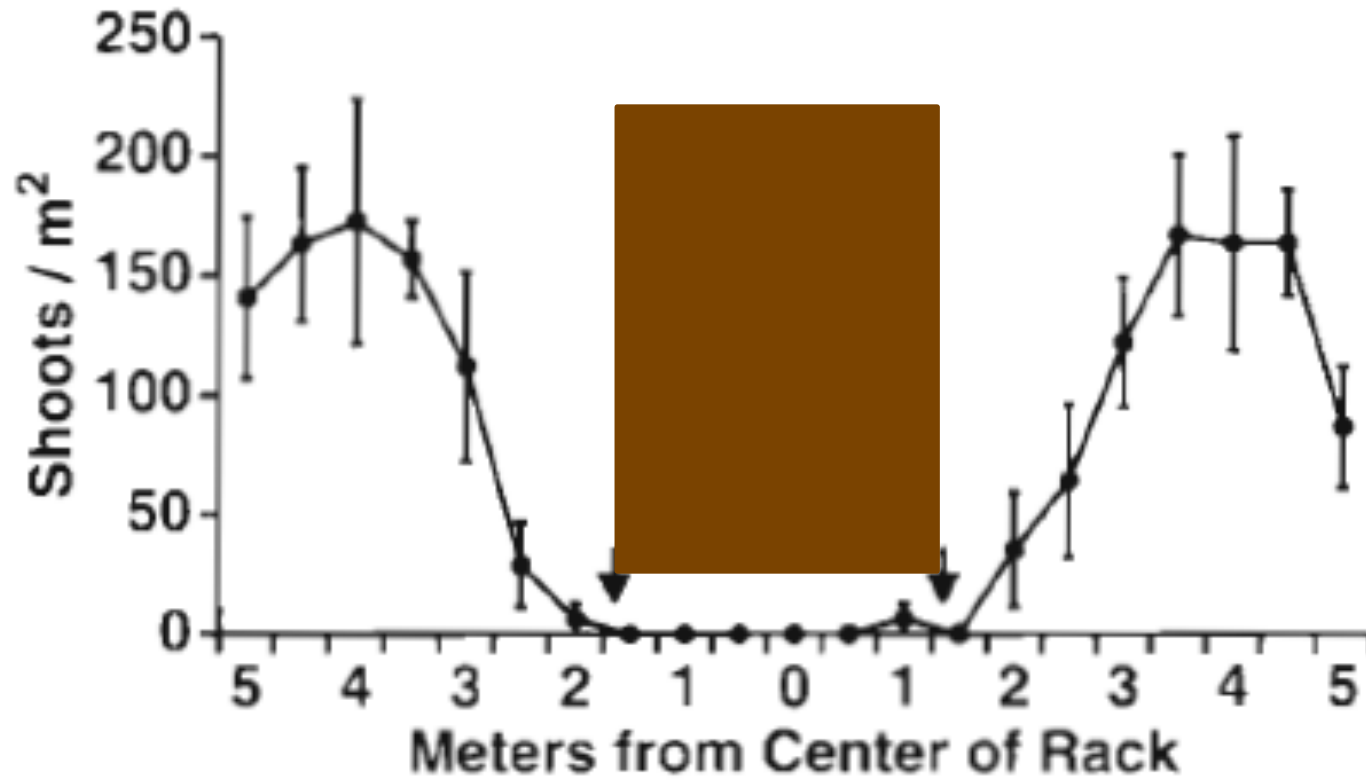
Nutrients – little evidence of nutrient limitation in WA



Lesson 3: What happens to *Z. marina* near shellfish aquaculture has not been thoroughly tested



Effects of racks do not extend far beyond footprint

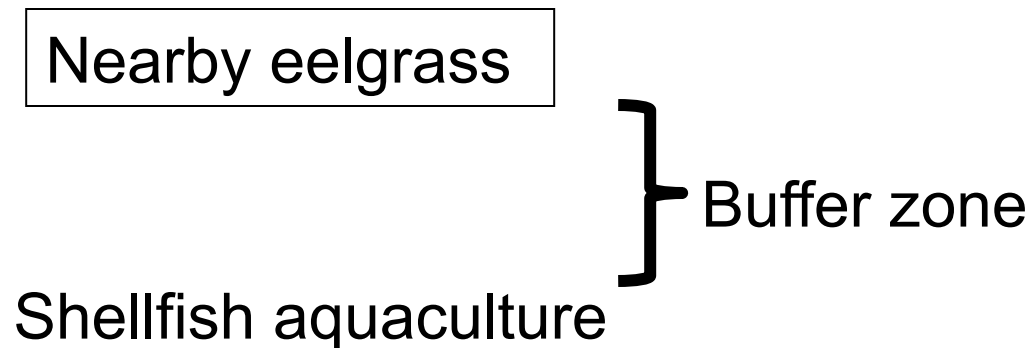


Everett et al. 1995

Management responses

Buffer zones around eelgrass are typically established at ~10 m, which exceeds negative effects of shellfish or structures.

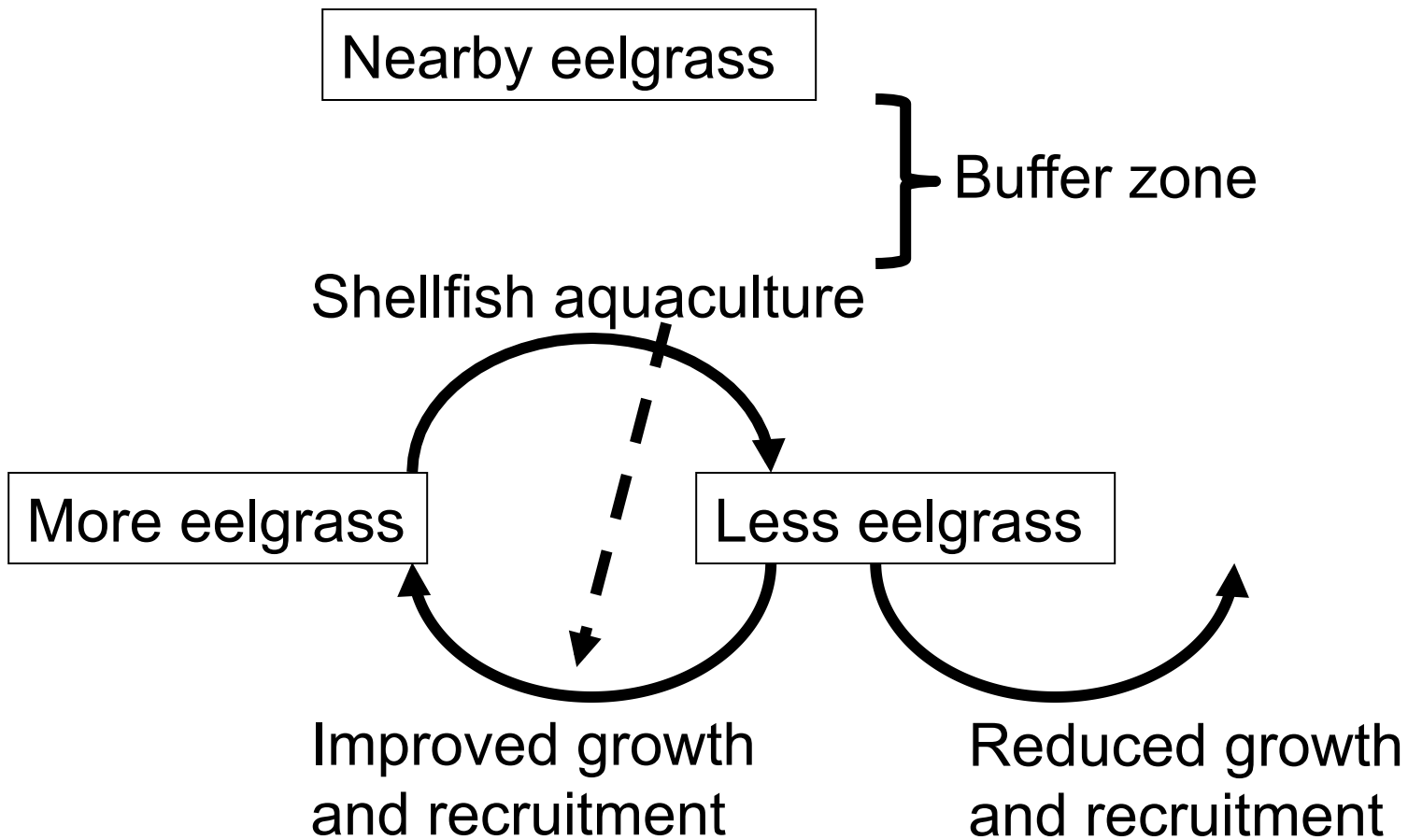
- Based on human behavior, not farm effects?
- Based on sediment movement during harvest?
- Or do buffer zones better allow eelgrass expansion?



Lower density of *Z. marina* on shellfish aquaculture beds, but rarely eliminated

Appearance of new eelgrass depends on seeds

From what we know so far (not much), farm effects are local



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