Marine Conservation Potential for Pearl Farming

The influence of pearl oyster farming on reef fish abundance and diversity in Ahe, French Polynesia

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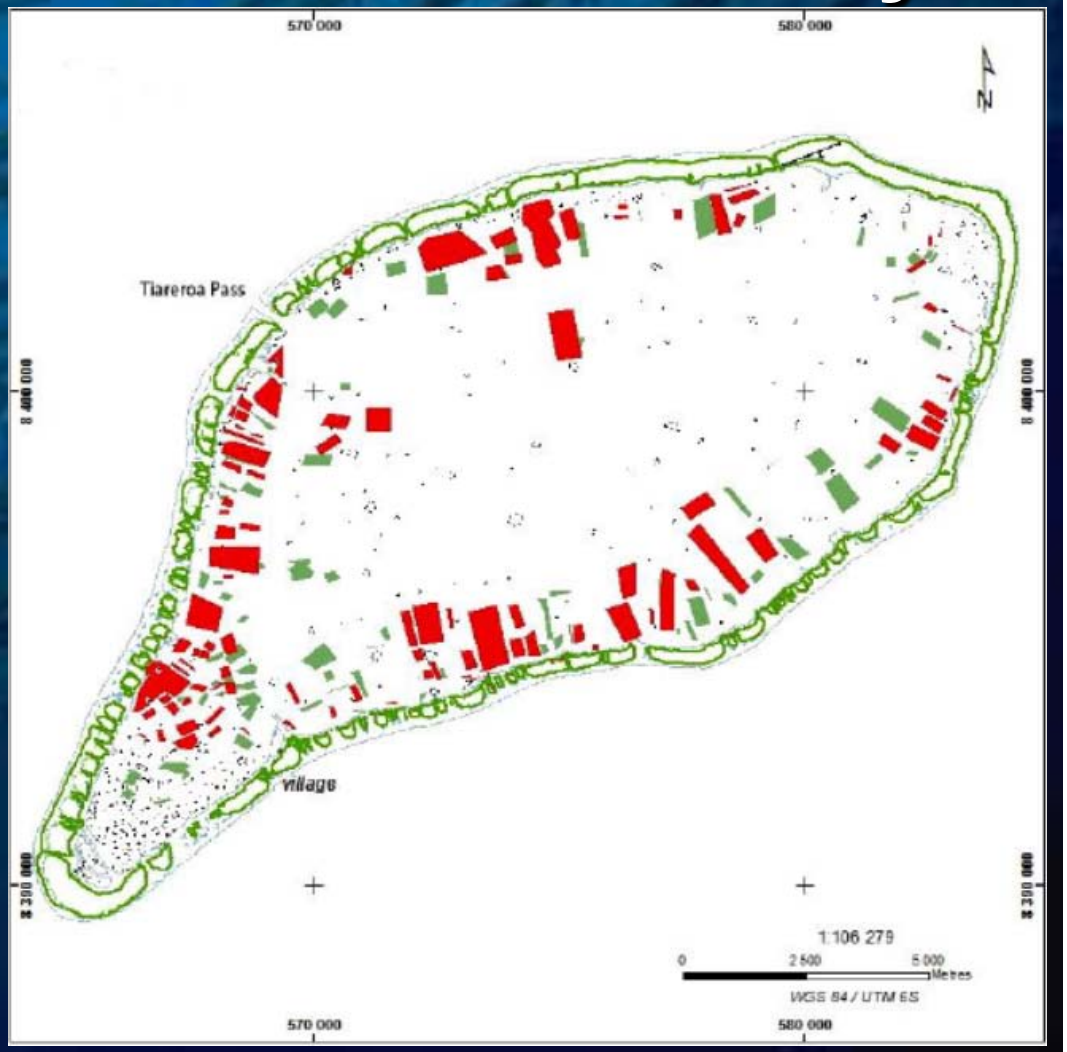
Andy Bardon

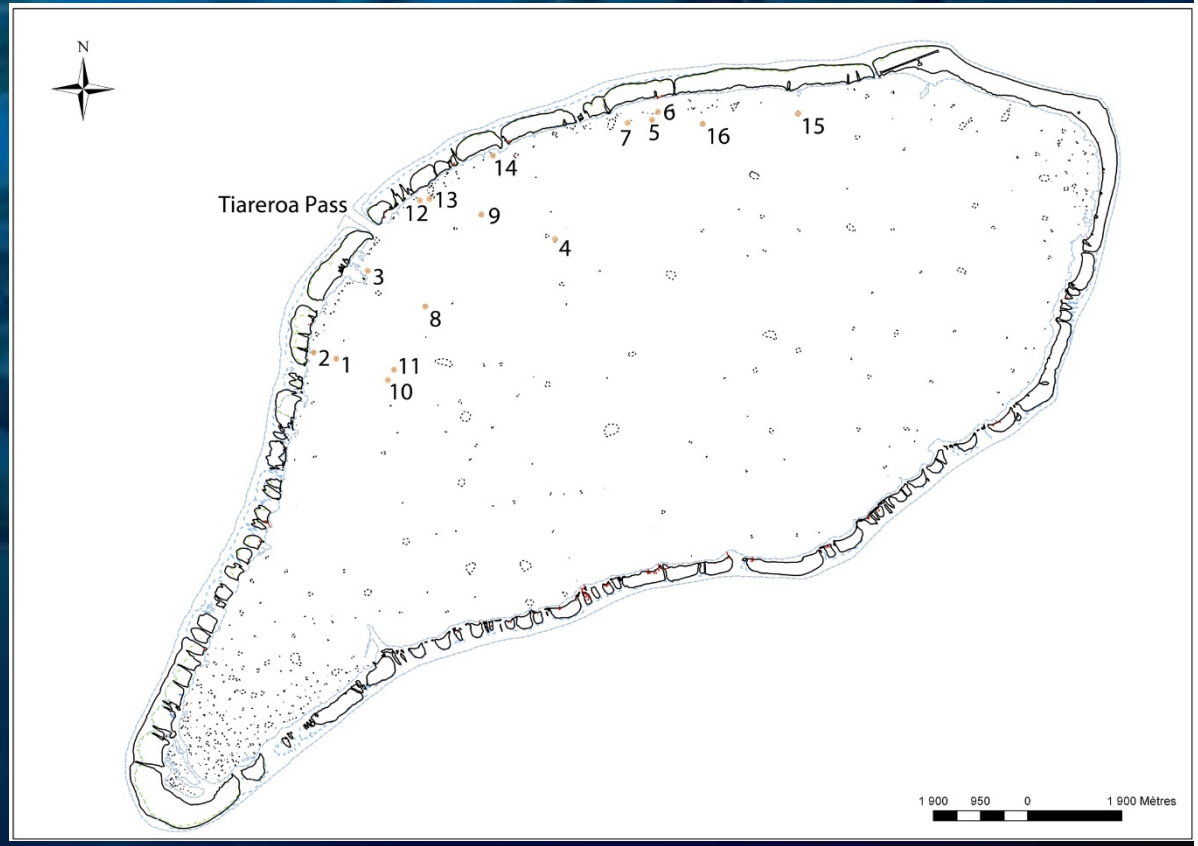
Basic Question: Does Pearl Farming Impact Fish Abundance and Diversity?

- Ahe lagoon with 77 farms covering 1188 ha (11% of lagoon area)
- Reef fishes an important component of lagoon biodiversity



Measuring Reef Fish Abundance & Diversity

- **Coral Bommie unit of measurement**
- **Bommies adjacent to or far from farms**



Measuring Reef Fish Abundance & Diversity

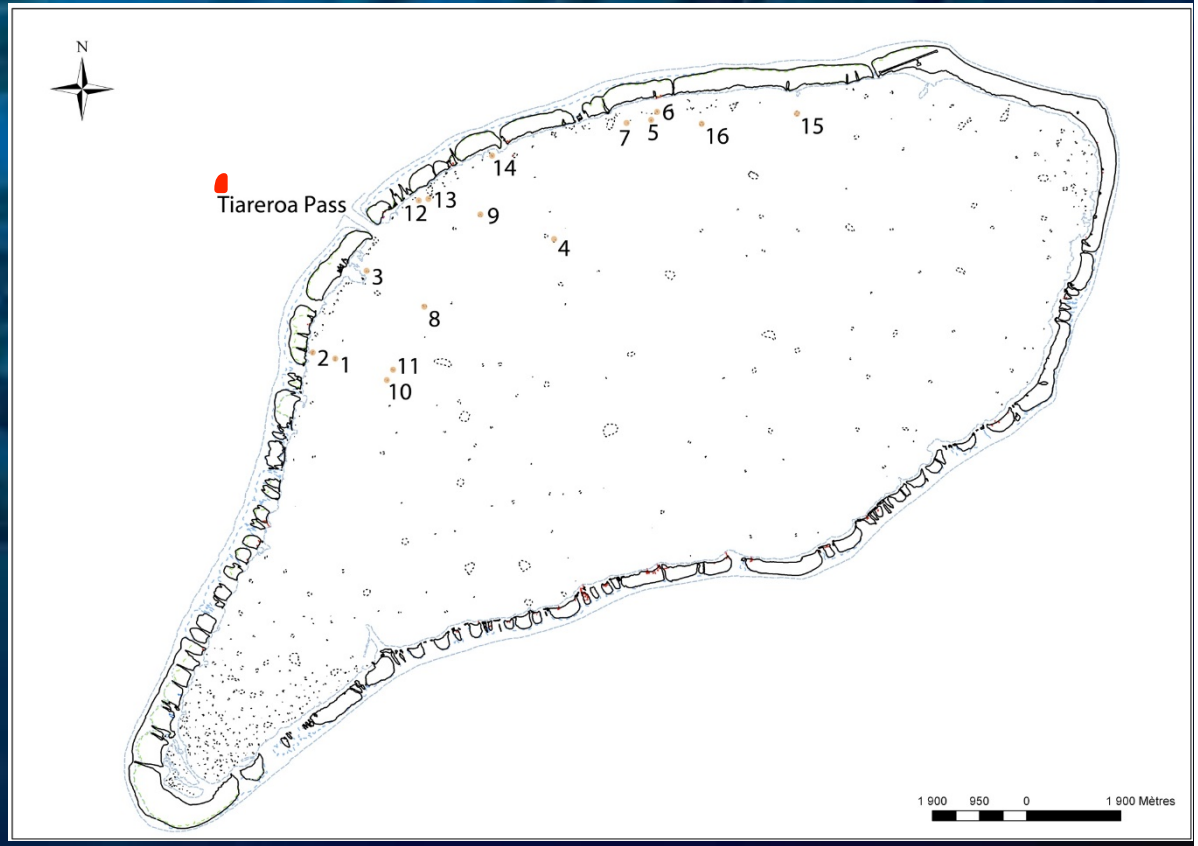
- Farms & fish intimately connected
- Imposing structures on reefs
- Cleaning nets potential impacts

Photo: A. Bardon

Photo: Josh Humbert

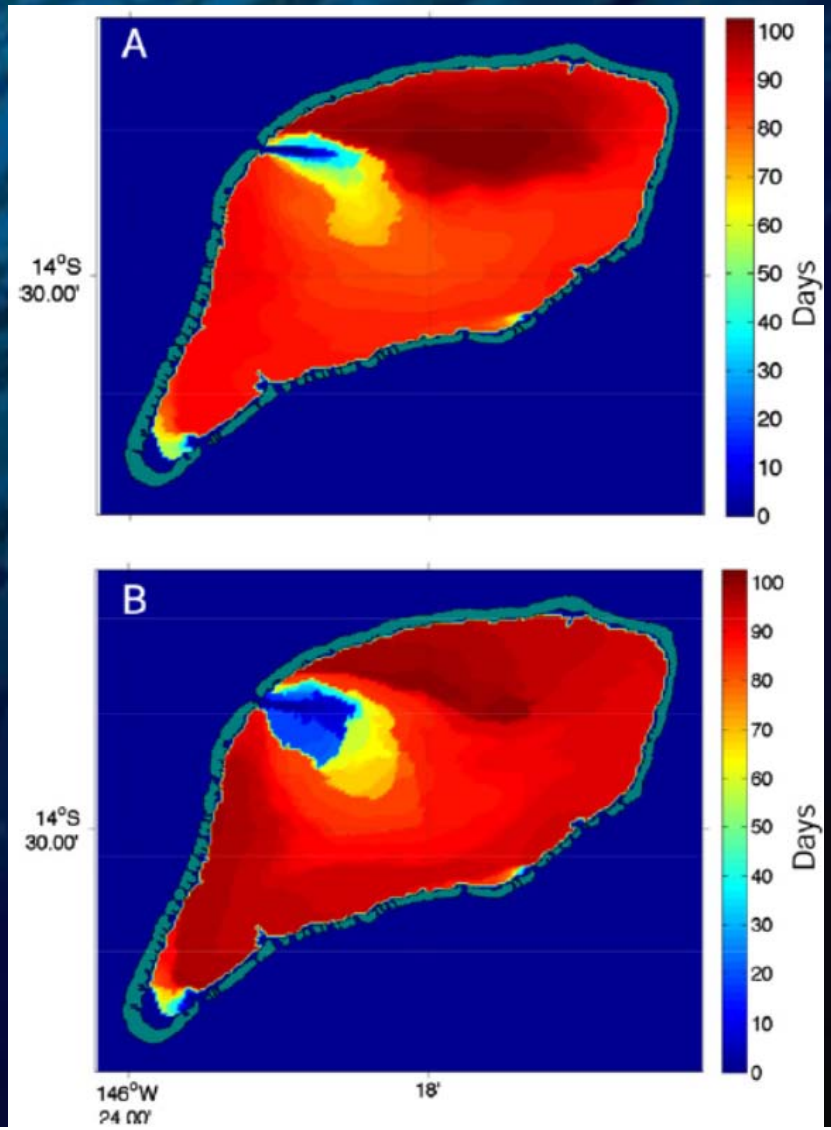
Measuring Reef Fish Abundance & Diversity

- **Other factors aside from farming can influence fish**
- **Position from pass**



Measuring Reef Fish Abundance & Diversity

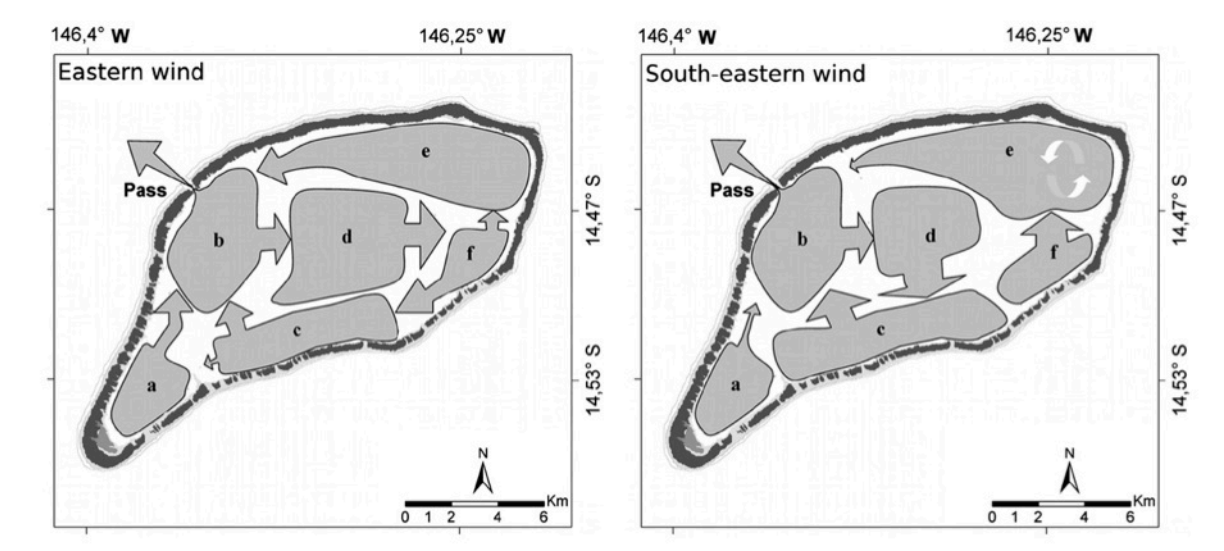
- Ahe lagoon very well studied
- Physical factors influencing fish communities
- Flushing rates in stationary (a) vs average trade winds (b)
- Position relative to pass



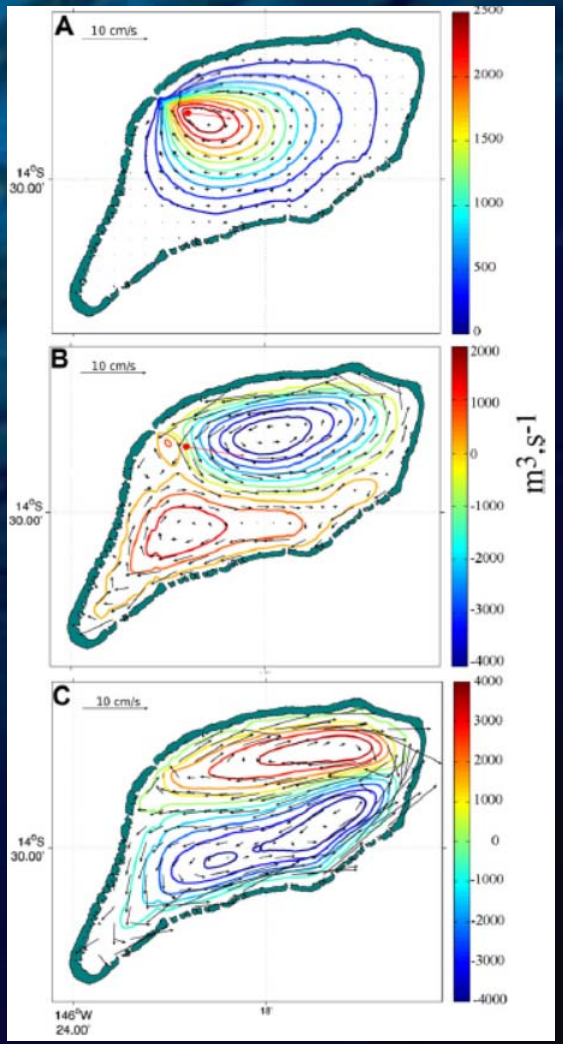
Dumas et al. (2012)

Measuring Reef Fish Abundance & Diversity

- **Circulation patterns influence movements of fish larvae and plankton (food source)**
- **Position relative to pass**



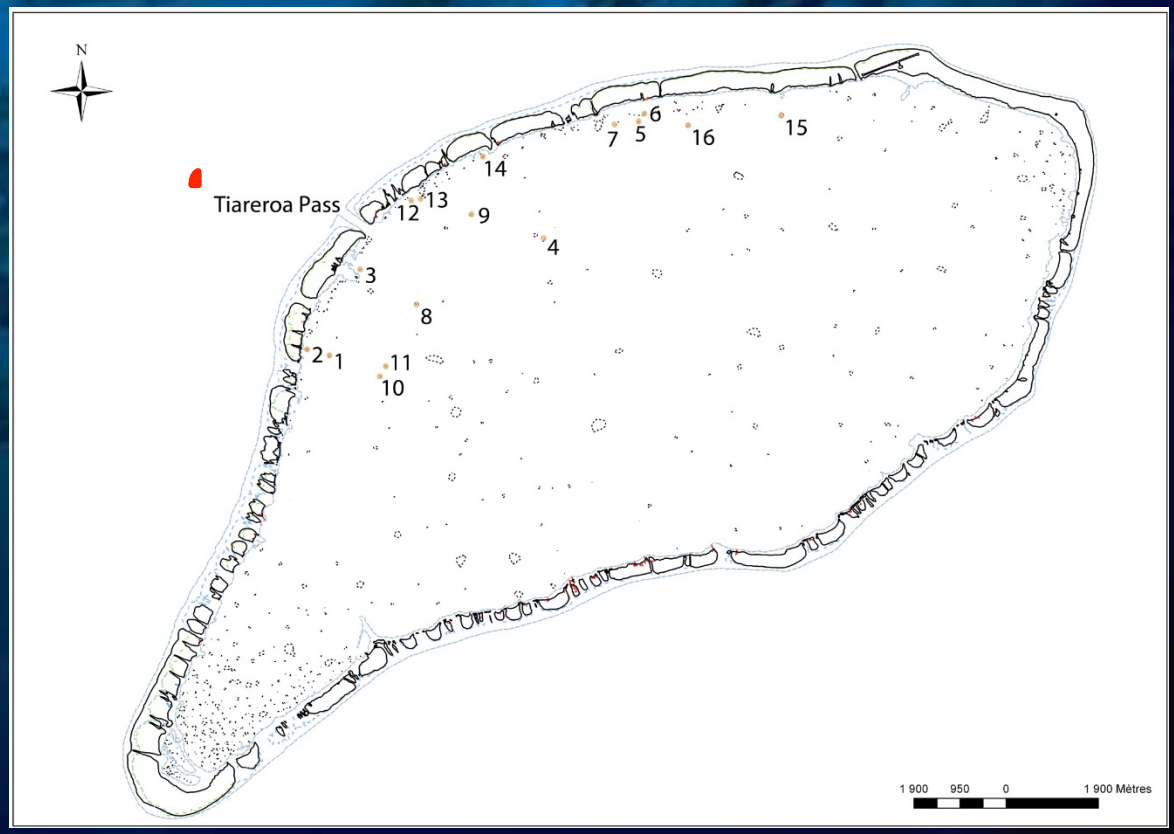
Larvae dynamics and exchange in Ahe lagoon. Source: Thomas et al. (2012)



Dumas et al. (2012)

Measuring Reef Fish Abundance & Diversity

- **Stations chosen to represent both proximity to pass and pearl farming activity**



Measuring Reef Fish Abundance & Diversity

- **Measured using Roving Census Method**
- **SCUBA & underwater slates**

Photo: A. Bardon

Photo: A. Bardon

Measuring Reef Fish Abundance & Diversity

- Measured using roving census method
- Timed 60 minute.
  20 meters to surface.
  bommie circumnavigation

Photo: A. Bardon

Photo: A. Bardon

Results

- Impacted = close to farming
- Position relative to pass
- Abundance (N) & diversity (H) coded different ways to test for robustness of census method

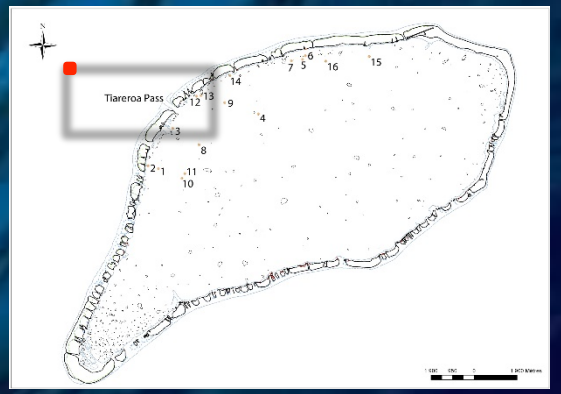


Table 2
Means of fish abundance (N_{1-1000}, $\sqrt{N}$, N_{1-4}) and species diversity ($H_{(N1-1000)}$, $H_{(\sqrt{N})}$, $H_{(N1-4)}$) at all censused stations ($n = 16$). N_{1-1000} and $H_{N1-1000}$ correspond to coding of abundance category as 1–1000 before square root transformation. $\sqrt{N}$ and $H_{(\sqrt{N})}$ correspond to coding of abundance category as 1–1000 and transformed as a square root. N_{1-4} and $H_{(N1-4)}$ correspond to abundance coded as 1–4. The numbers in parentheses after the mean represent the number of stations sampled in the category followed by the standard deviation.

	Impacted	NoDirect Impact	NPass	SPass
N_{1-1000}	11,468 (7, 2062.29)	7591.67 (9, 1763.61)	9780.09 (11, 2708.47)	8204 (5, 2630.03)
$\sqrt{N}$	630.71 (7, 80.282)	512.56 (9, 73.850)	591.45 (11, 91.653)	504.40 (5, 82.494)
N_{1-4}	174.43 (7, 10.690)	162.67 (9, 17.255)	173.55 (11, 13.359)	155.20 (5, 12.950)
$H_{(N1-1000)}$	3.100 (7, 0.141)	3.047 (9, 0.131)	3.120 (11, 0.133)	2.958 (5, 0.022)
$H_{(\sqrt{N})}$	3.831 (7, 0.068)	3.840 (9, 0.106)	3.870 (11, 0.085)	3.762 (5, 0.037)
$H_{(N1-4)}$	4.172 (7, 0.029)	4.150 (9, 0.101)	4.185 (11, 0.068)	4.104 (5, 0.069)

Total number of species observed across 16 stations was 151.

Results

- 2-way ANOVA (no significant interaction -> Type I)
- Pearl farming POSITIVELY influences fish abundance

Source	*F*	Pr > *F*
N_{1-1000}		
General model	21.38	<0.0001**
N_{1-1000} **(Type I SS)**		
Impact	52.12	<0.0001**
Position	19.77	0.0010**
Distance Shore	3.09	0.1064
Distance Pass	10.53	0.0078*

Results robust despite coding method

Results

- 2-way ANOVA (no significant interaction -> Type I)
- Fish diversity NOT INFLUENCED by pearl farming

Source	*F*	Pr > *F*
$H_{(N1-1000)}$		
General model	2.70	0.0867
$H_{(N1-1000)}$ **(Type I SS)**		
Impact	0.89	0.3653
Position	8.89	0.0125*
Distance Shore	0.12	0.7316
Distance Pass	0.88	0.3682

(actually a slight increase with impact and non-significance maybe because of limited sample size)

- ANOSIM results show basic community structure not impacted by Pearl Oyster Farming

Farming Increases Fish Abundance?

- **Structures are fish sustaining devices (food & shelter)**
- **Some surgeonfishes and butterflyfishes more abundant**

Photo: A. Bardon

Photo: Josh Humbert

Farming Does Not Harm Biodiversity?

- **No DECREASE in diversity near fish farms**
- **No fundamental change in fish communities**

Photo: A. Bardon

Photo: Josh Humbert

Philippine Comparisons

- Preliminary data from Jewelmer Pearl Oyster Farms at Bugsuk Island: higher diversity near farms
- Need to follow up to confirm
- Roving Census Method repeatable across different geographic & times scales; powerful with sufficient sample sizes
- Pearl oyster farms:
  - Economic benefit
  - Environmental awareness (Jewelmer model)
  - De facto Marine Protected Areas (Enforcement)

Conclusions

- Presence of pearl farms increases local abundance of reef fishes (structures food and shelter source)
- Farms do not degrade localized diversity
- For Ahe lagoon, present farming model a positive conservation statement:
  - Farming changes local habitat but in a positive way
  - Pearl farming represents a positive conservation/ business model (product, local livelihoods, conservation ethic)

KAMOKA

Jewelmer JOAILLERIE

- Remaining questions:
  - Long term effects (from no farming to long term)
  - Site specific effects (Philippine follow up, elsewhere)
  - Develop pearl farming conservation ethic guidelines

Thank you!!

Photo: A. Bardon