In-situ measurements of environmental variables at three Hawaiian deep sea coral patches

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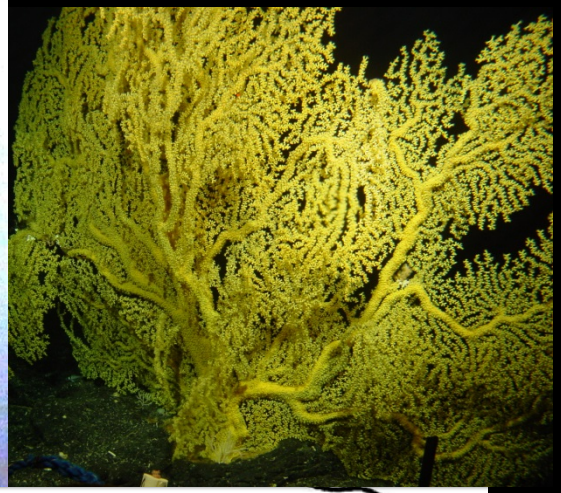
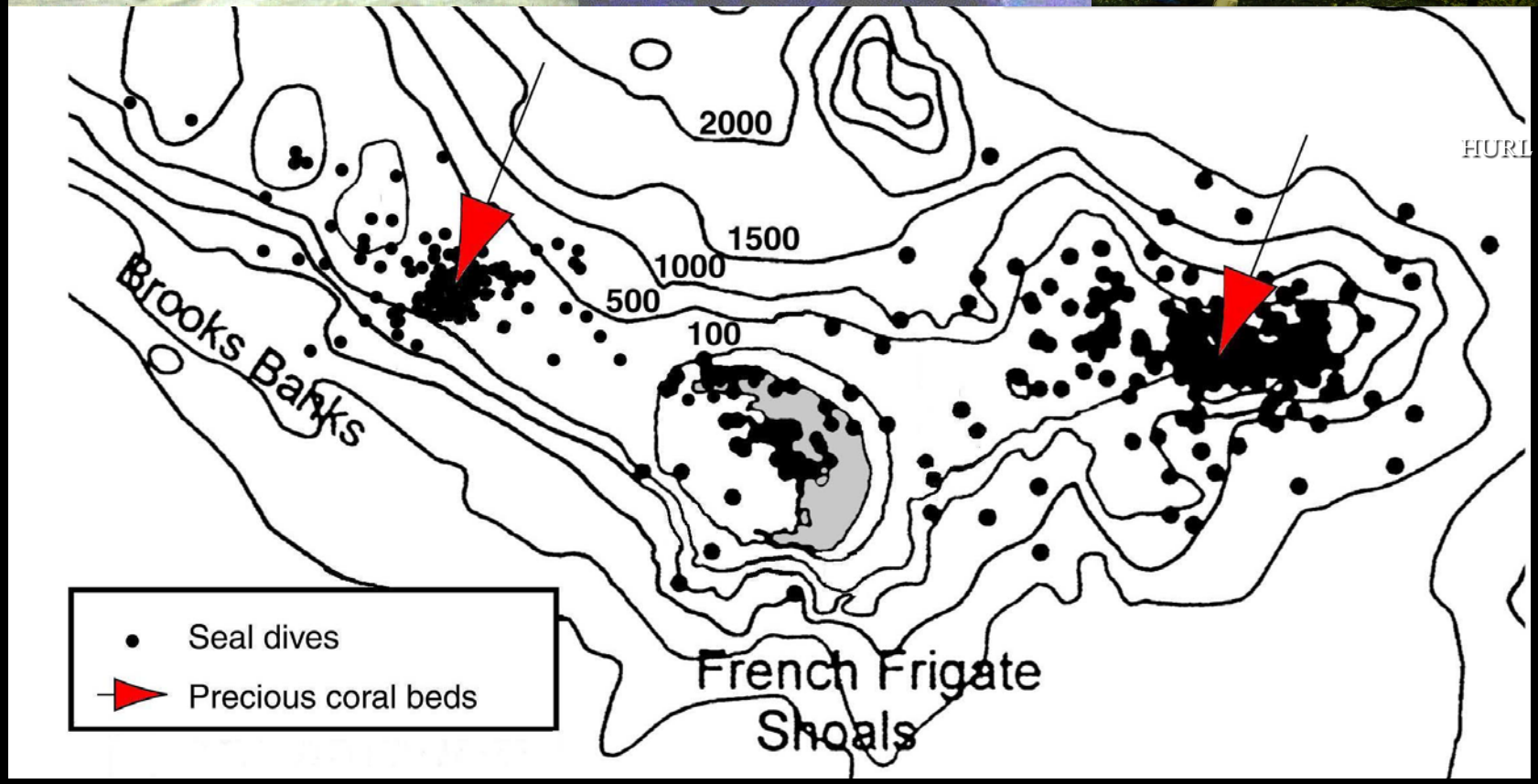
What are deep corals

- Azooxanthellate
- 50-2000+ m
- Suspension feeders
- Slow growing
- Long lived
- Independent colonies found in patches (not reef building)

Patchy nature of deep corals

- The product of the right environmental conditions over substrate suitable for coral settlement and growth.
- Can we use a comparative approach to discern the relative importance of some of these variables?




2000
1500
1000
500
100
Brooks Banks
French Frigate Shoals
Seal dives
Precious coral beds

Video courtesy of Baco-Taylor and Nat. Geo. TV

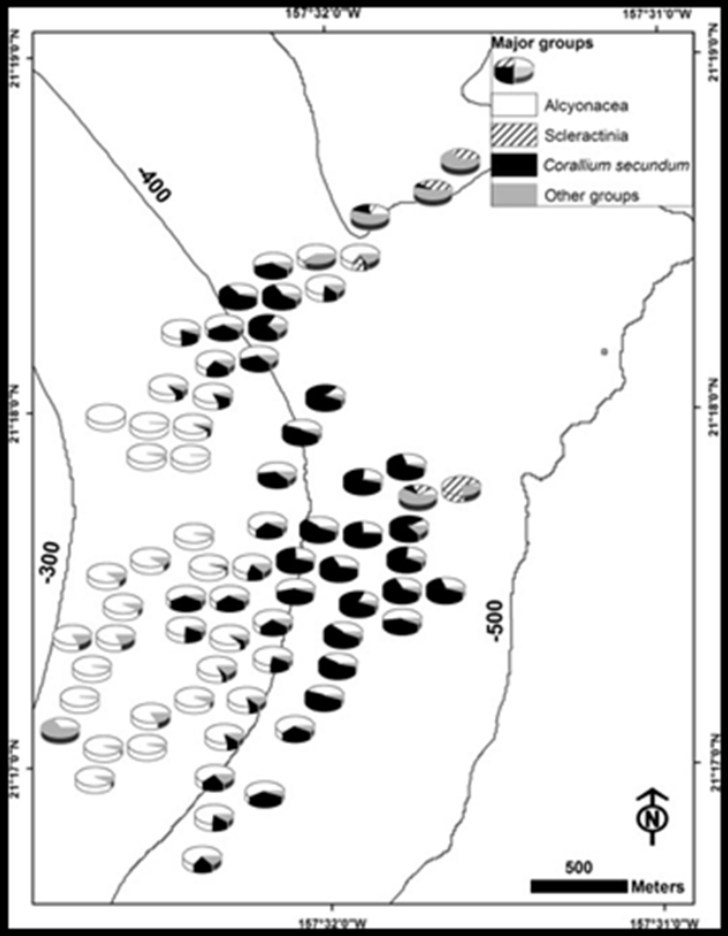
Precious coral fishery

- Corals harvested
  - Pink, gold, and black

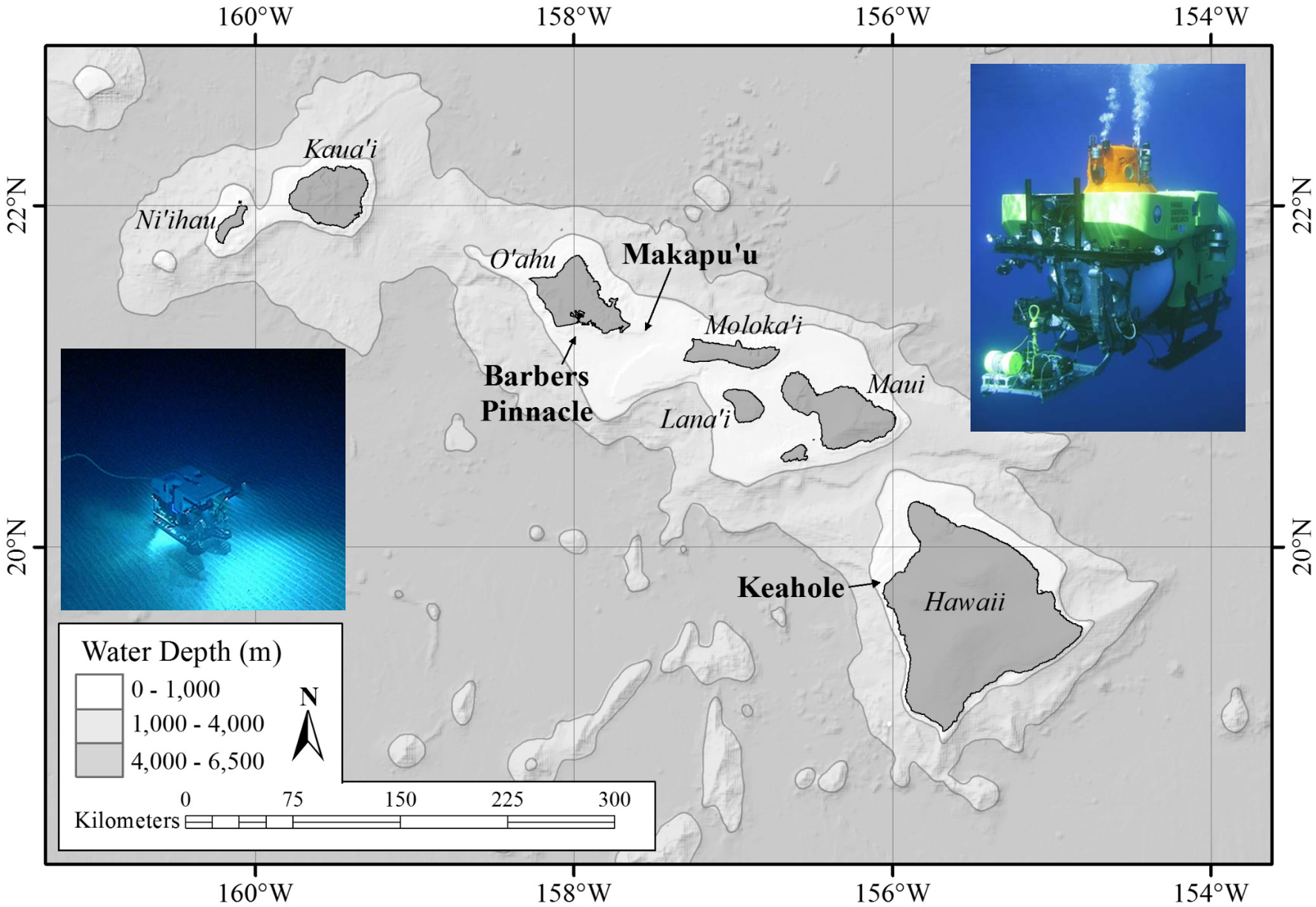
- Fishing (all in the main islands)
  - Since 1950's Diver collection of black coral
  - 1966-69 dredging pink & gold
  - 1972-79 submersible collection pink & gold
  - 1999-2001 Submersible collection pink & gold

Makapuu Precious coral bed

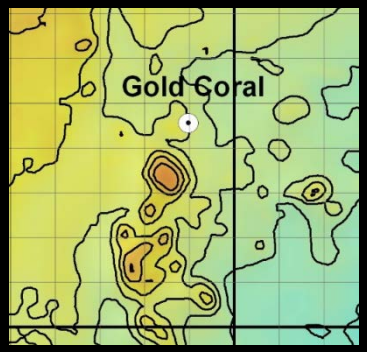
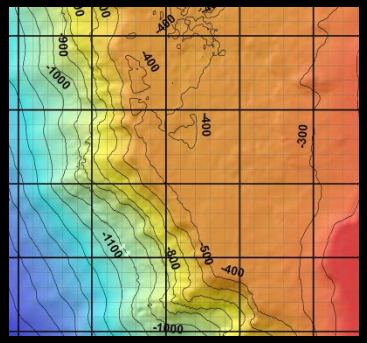
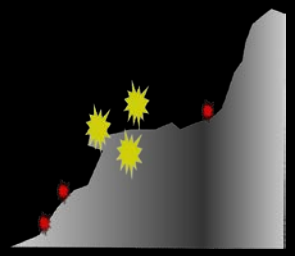
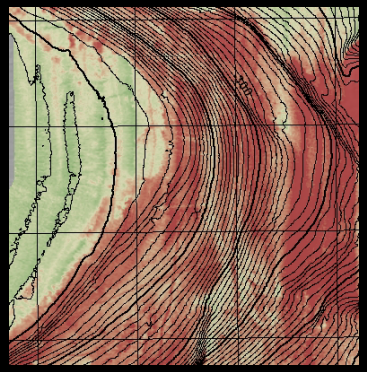
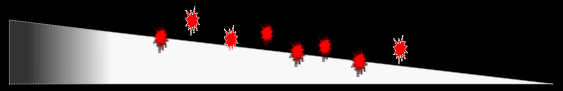
- **Precious corals** **(known depth range)**
  - Gold coral, Kulamanamana haumeaae (325-624 m)
  - Bamboo, Acanella dispar (275-575 m)
  - Red coral, Hemicorallium laauense (275-575 m)
  - **Pink coral, pleurocorallium secundum (225-575 m)**



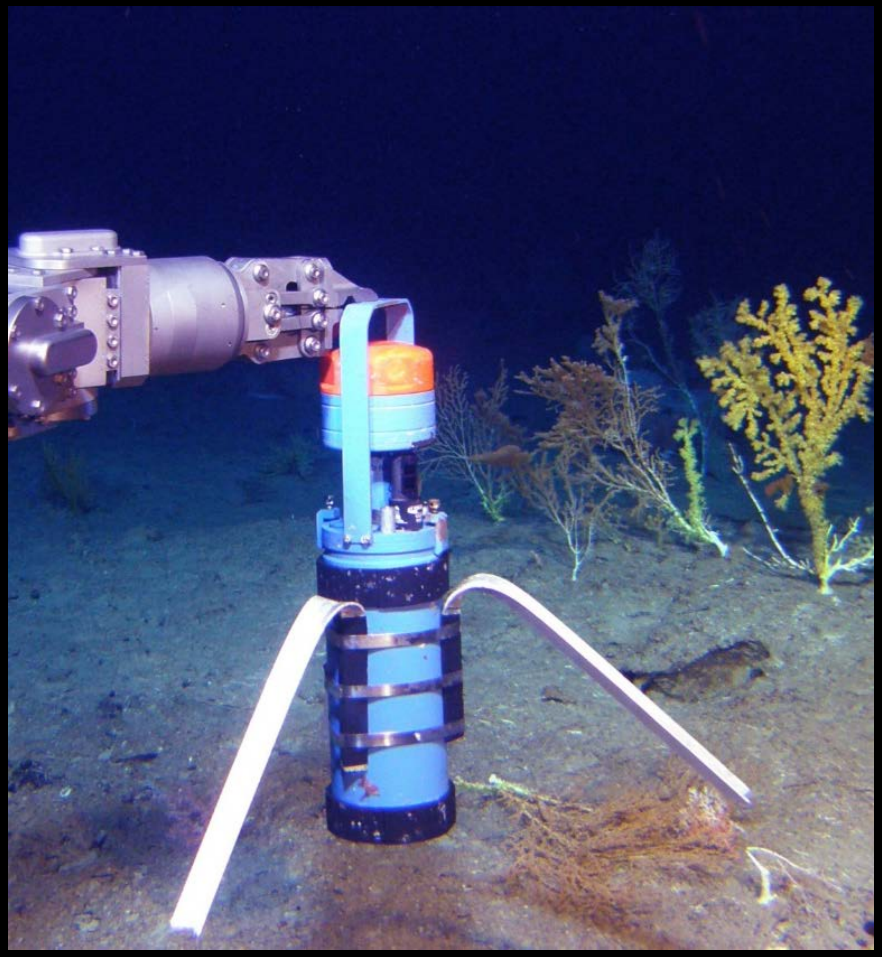
Local hydrography may have significant influence at small spatial scales (Long and Baco 2013)


160°W
158°W
156°W
154°W
22°N
20°N
Kaua'i
Ni'ihau
O'ahu
Makapu'u
Moloka'i
Barbers
Pinnacle
Maui
Lana'i
Keahole
Hawaii
Water Depth (m)
0 - 1,000
1,000 - 4,000
4,000 - 6,500
N
0
75
150
225
300
Kilometers

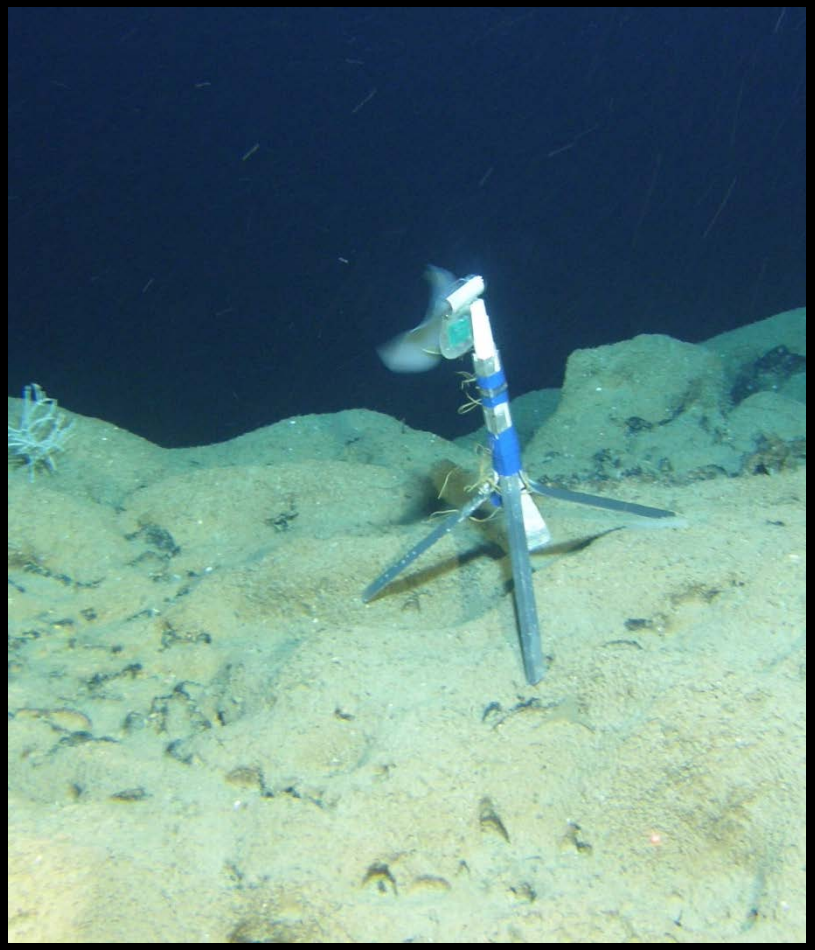
Physiography of coral beds

	Patch size	Common precious coral taxa
	0.05 square km	Gold coral Kulamanamana haumeaae Bamboo Acanella dispar
	 2.7 square kms	Gold coral Kulamanamana haumeaae Bamboo Acanella dispar Red coral Hemicorallium laauense
	 12.5 square kms	Gold coral Kulamanamana haumeaae Bamboo Acanella dispar Red coral Hemicorallium laauense Pink coral Pleurocorallium secundum

Instruments

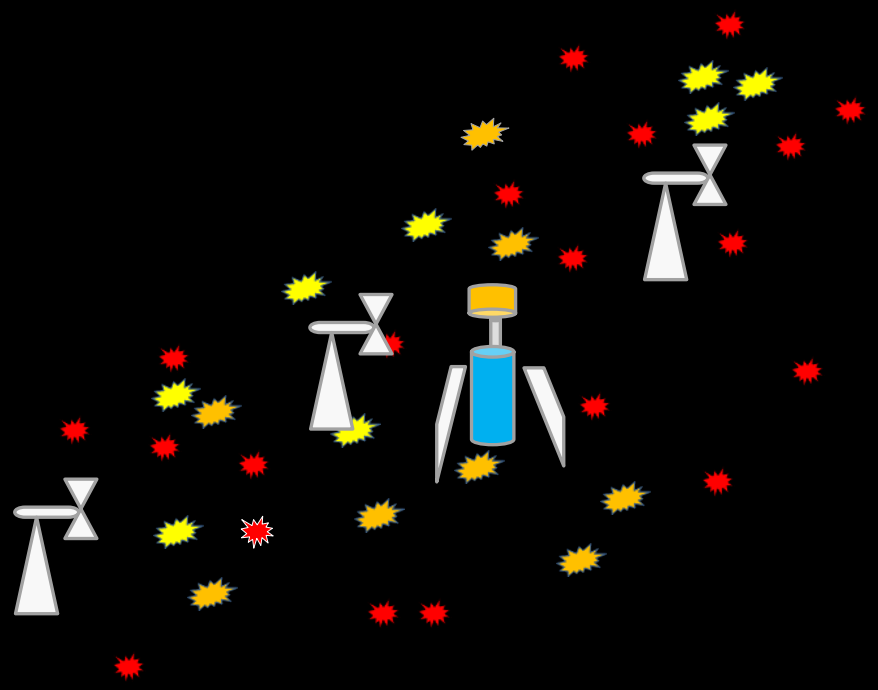


Temperature
Flow rate
Current direction
Turbidity

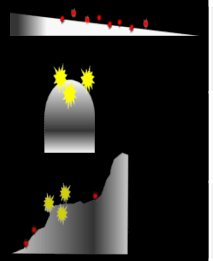


Temperature
Flow rate

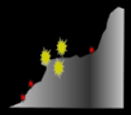
Center (in) and edge (out) placement

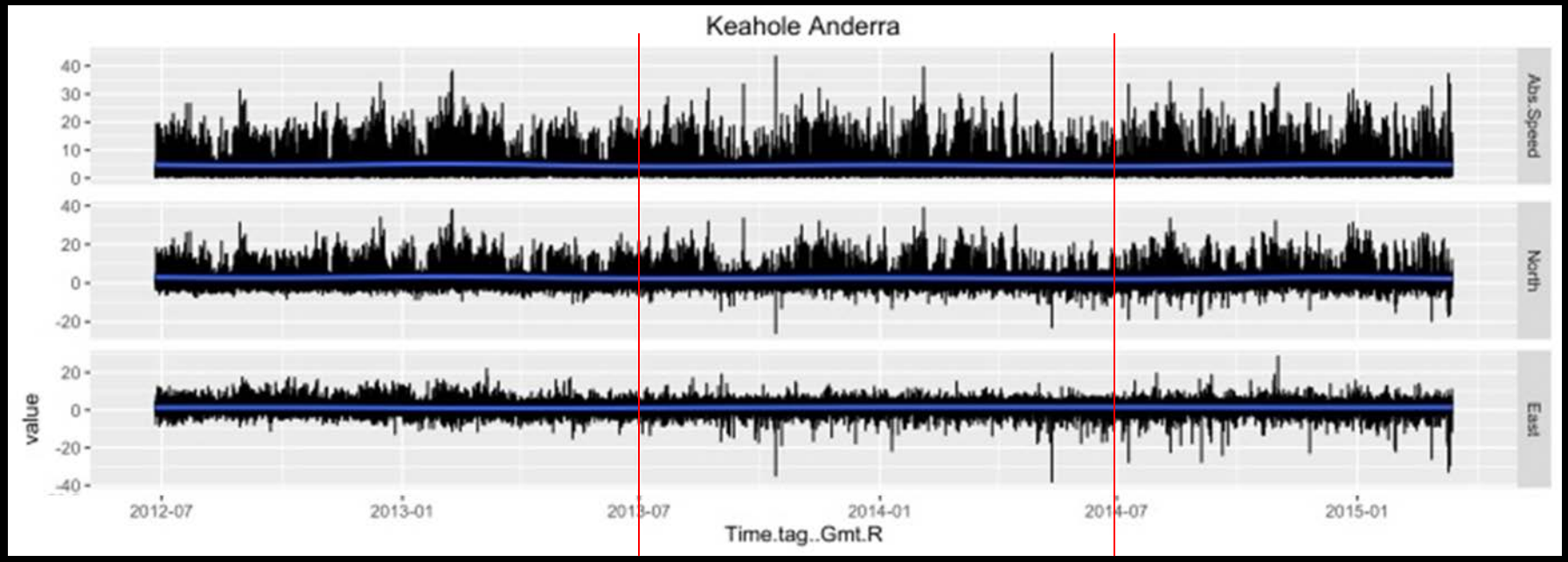


Study site sampling

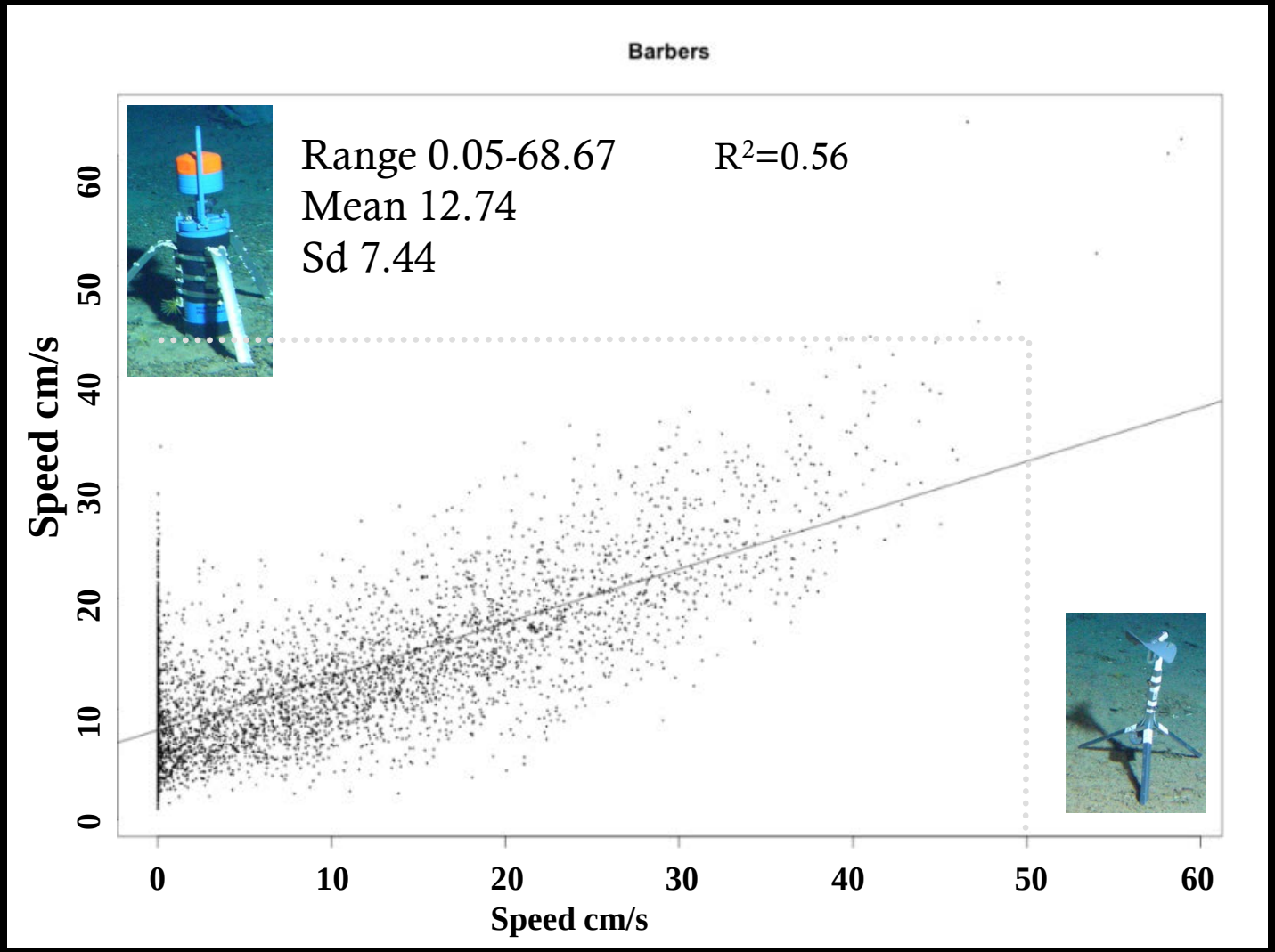


Site	Year	Duration	Depth m	Mean °C (SD)
Makapuu	2007	6 months Nov - Apr	415	8.3 (0.77)
Barbers Pinn.	2013	7 months, Dec-July	330	10.3 (1.5)
Keahole	2012	2.5 years	379	8.2 (0.39)

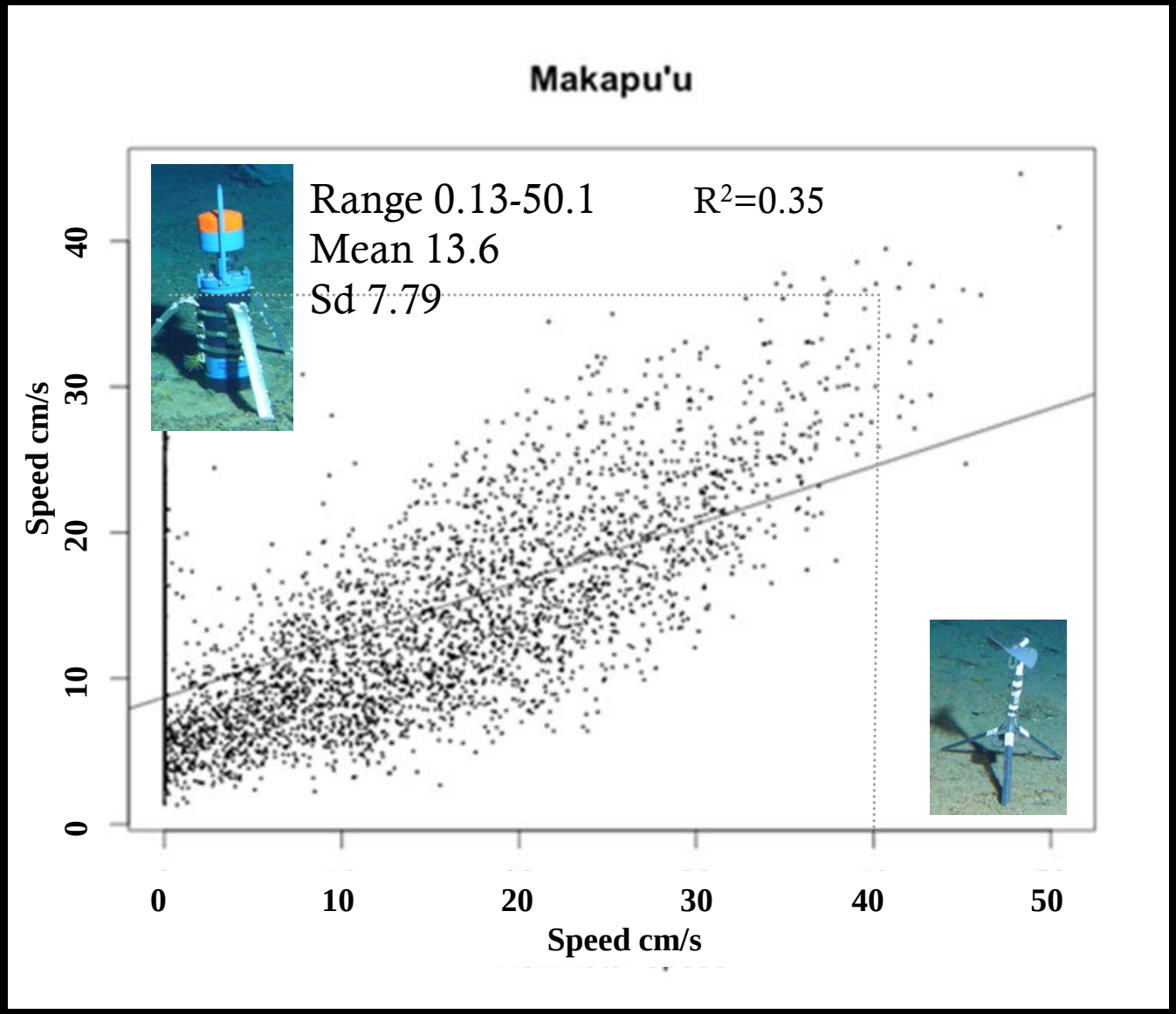
Multi year at 



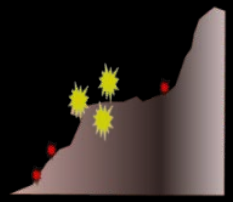
Flow speed Barbers Pinnacle

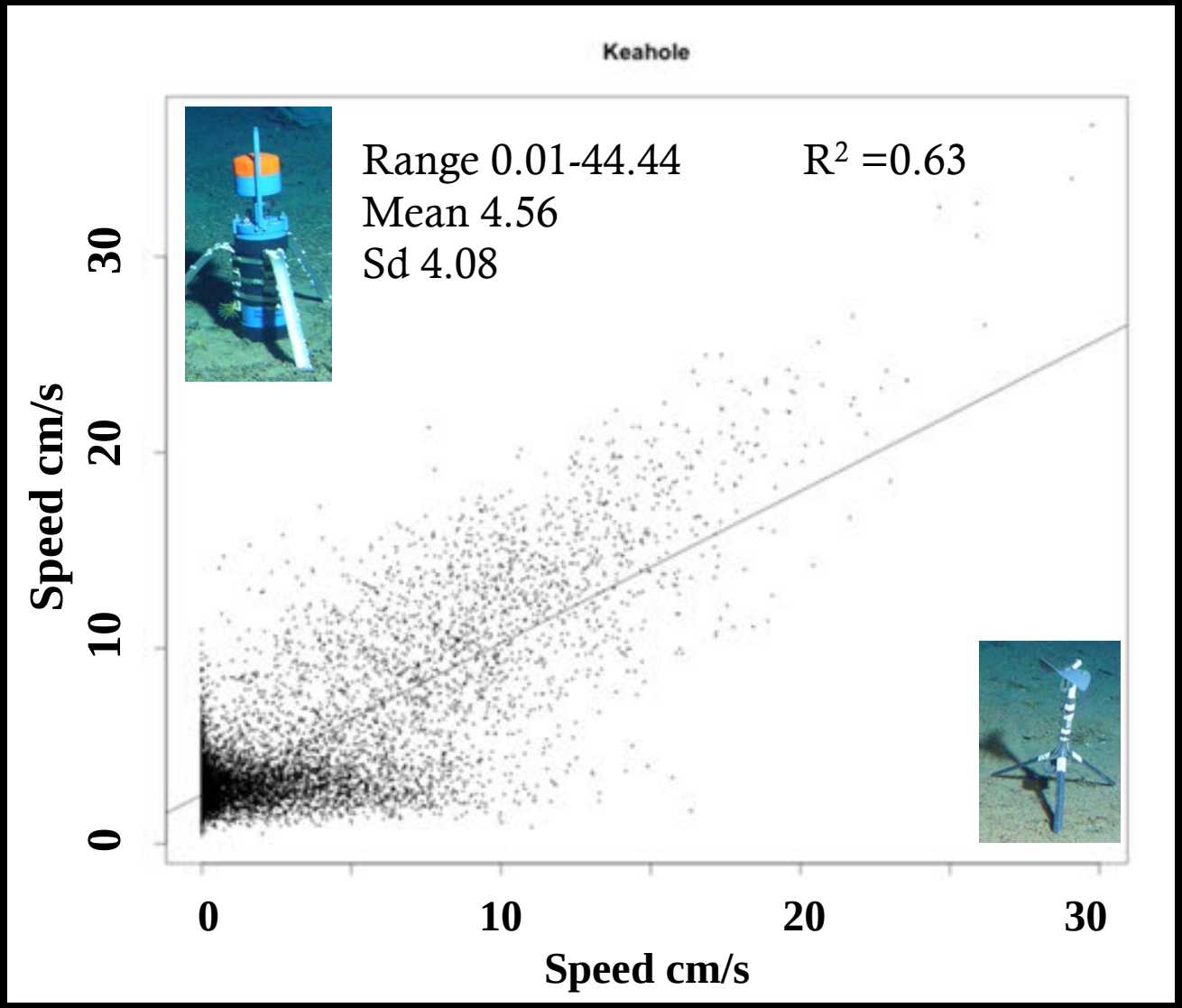


Flow speed Makapuu

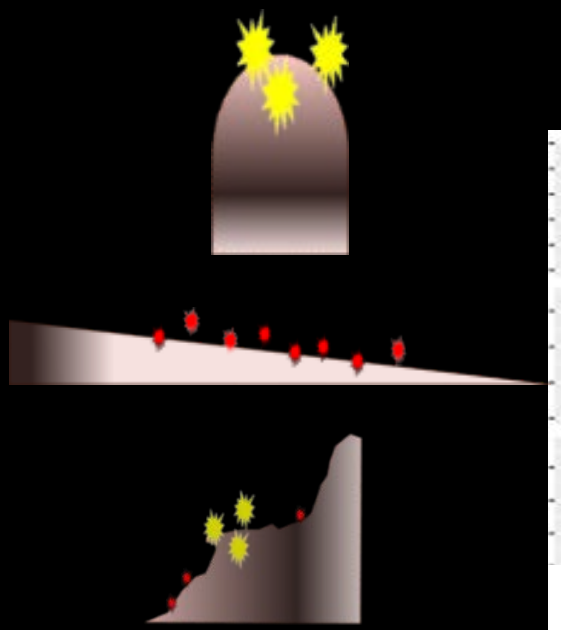


Flow speed Keahole

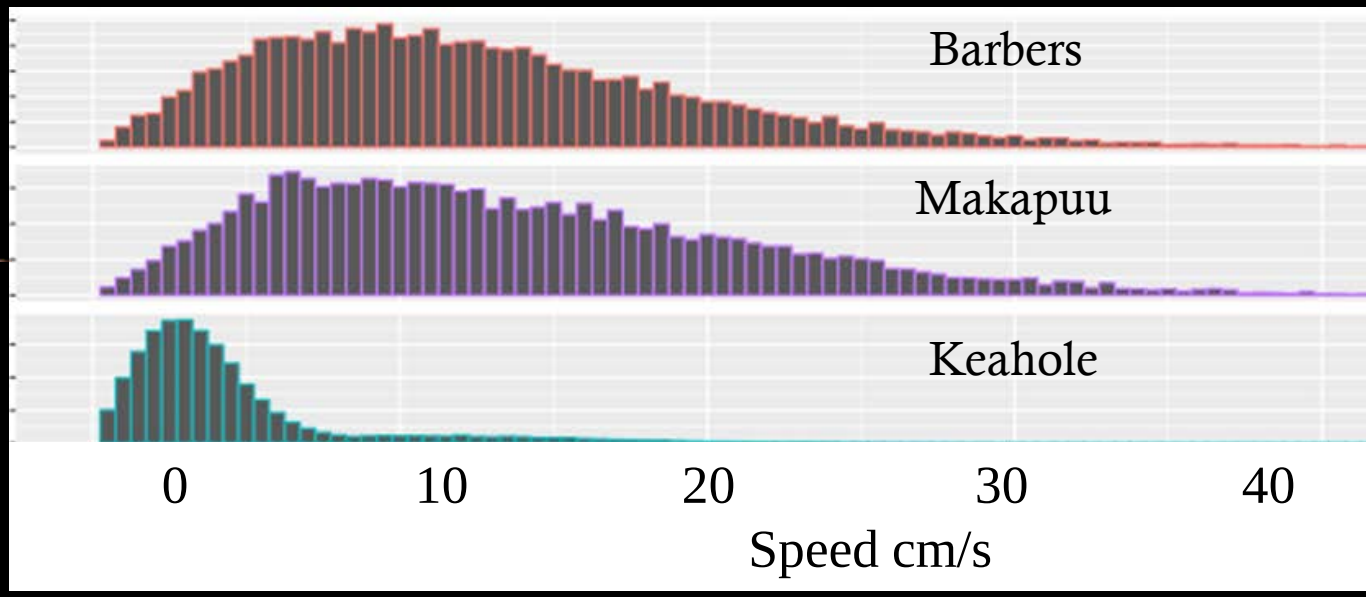




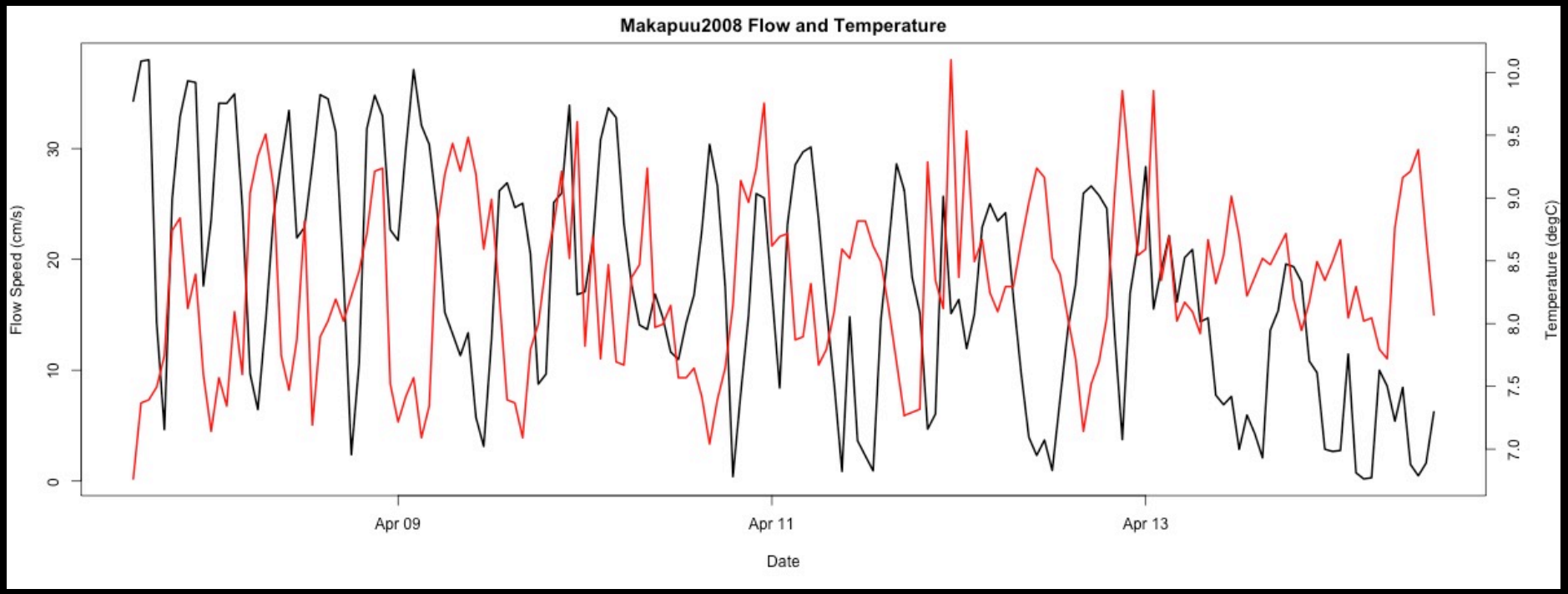
Flow speed



Frequency Plots

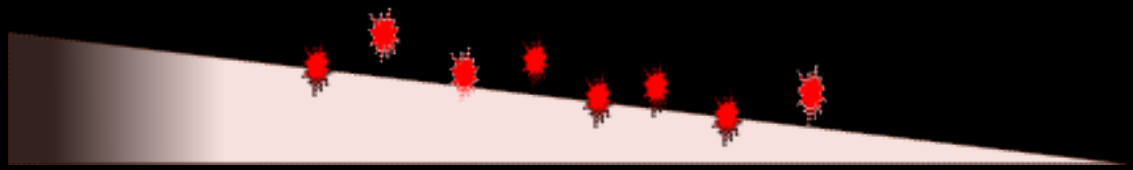


Flow and temperature Makapuu

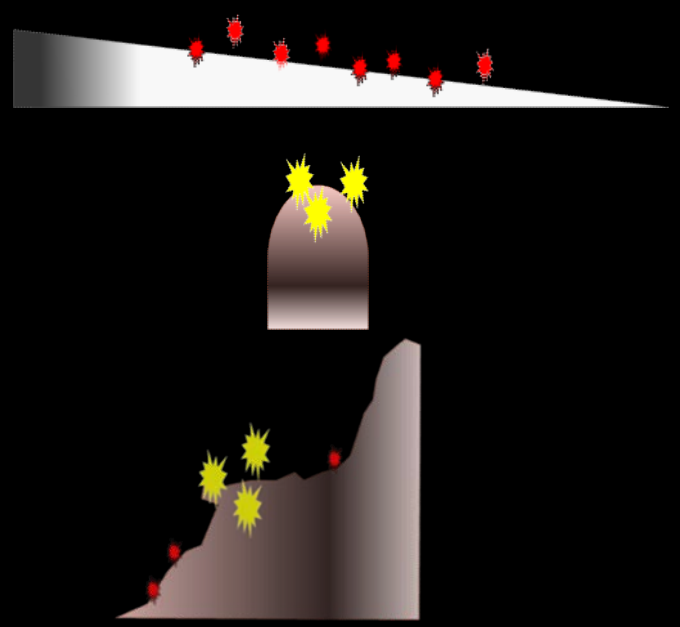


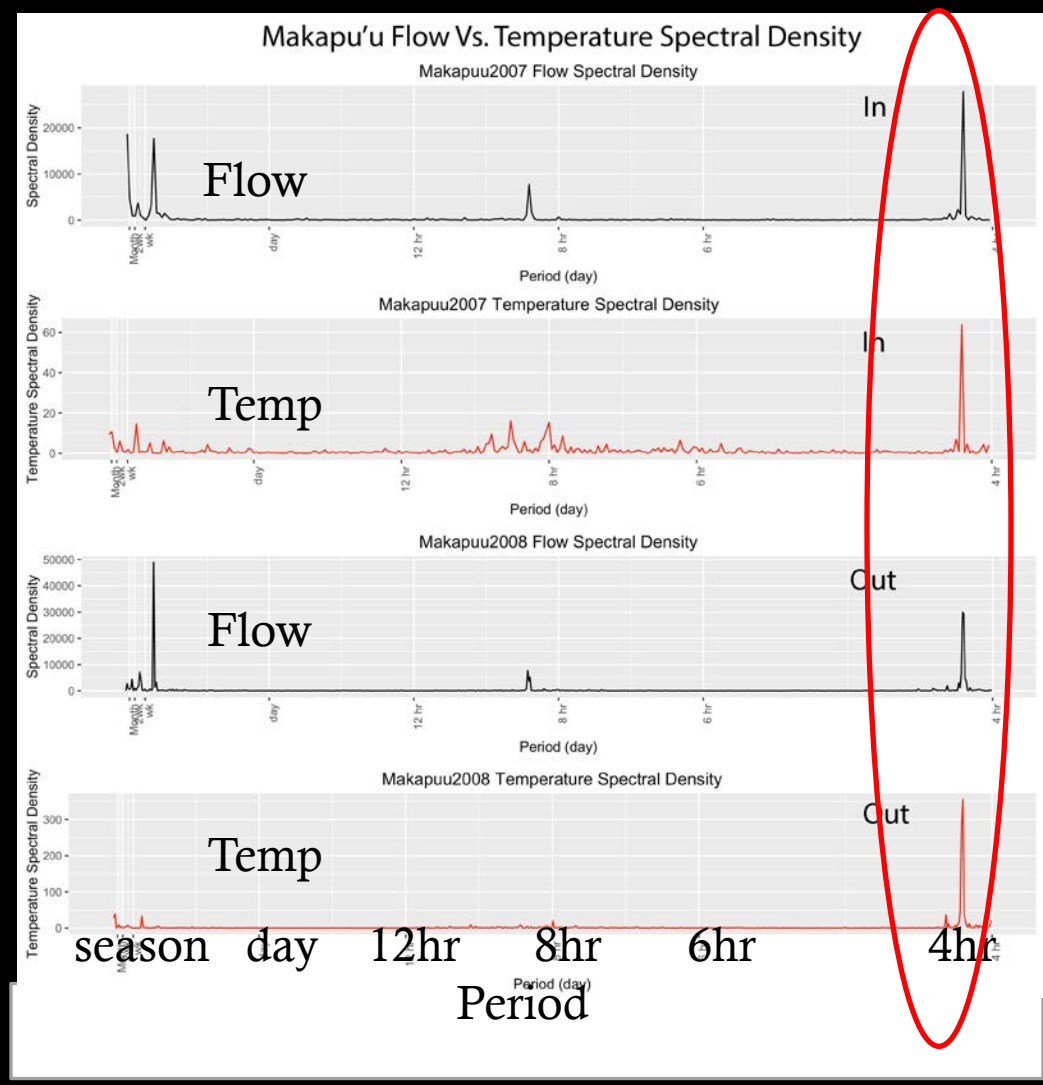
At this scale correlations between flow and temperature were weak

- But the temporal spectral signals match up well at all sites



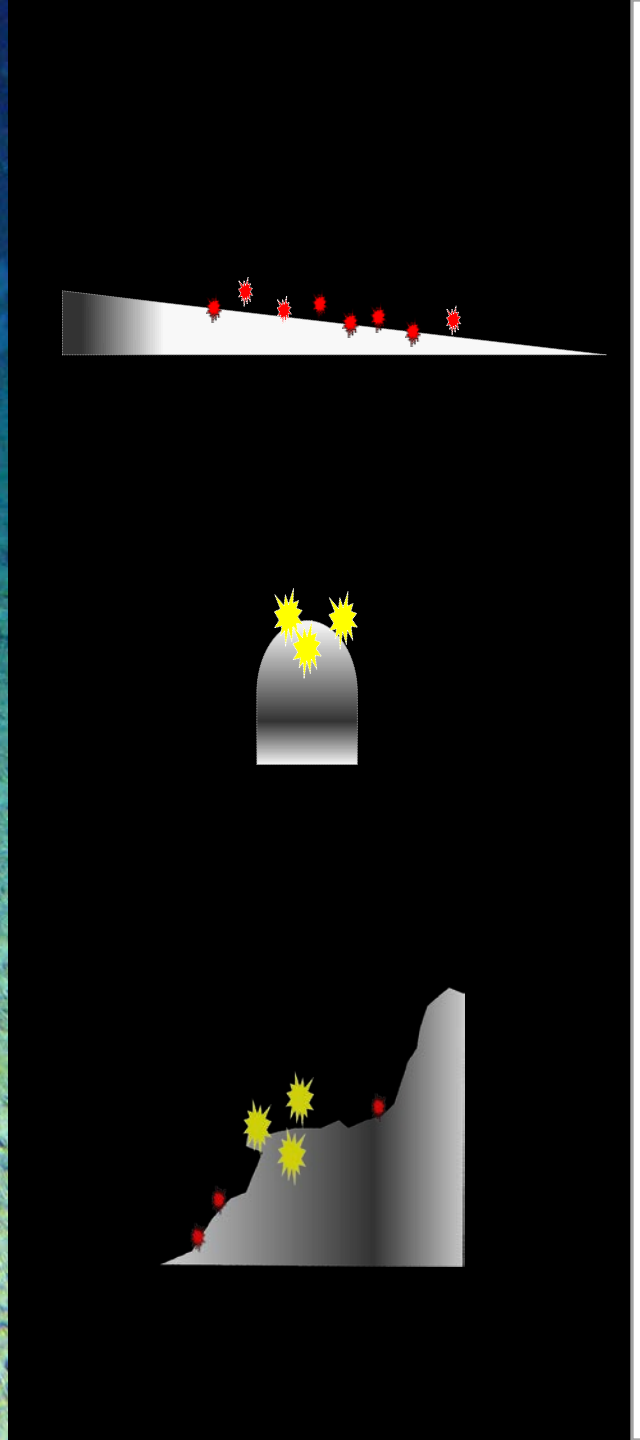
Flow and temperature –spectral plot

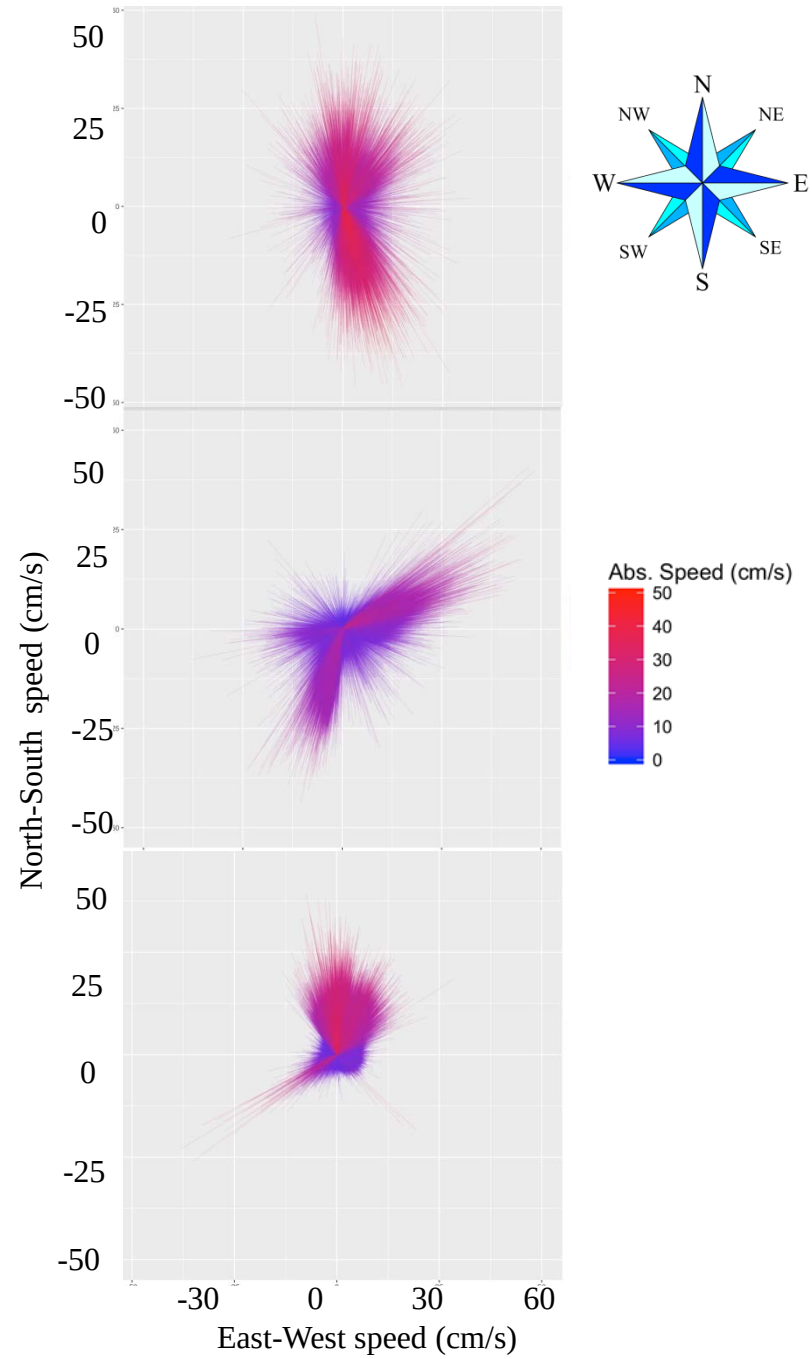




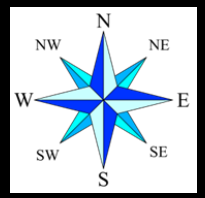
Changes in temperature and flow (regardless of direction) controlled by tide cycle

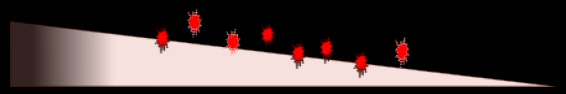
Flow direction

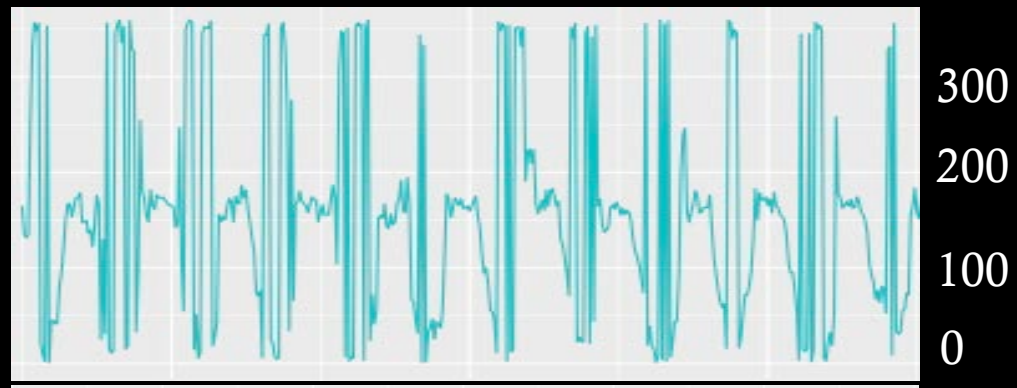


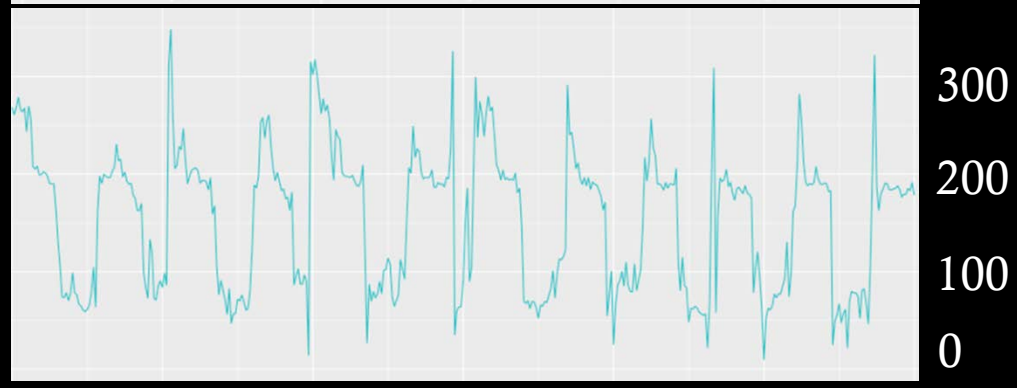


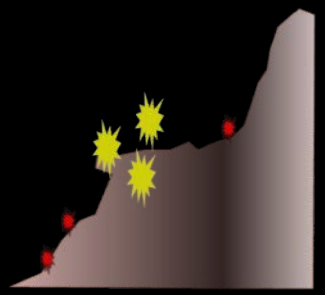
Tidal direction of flow

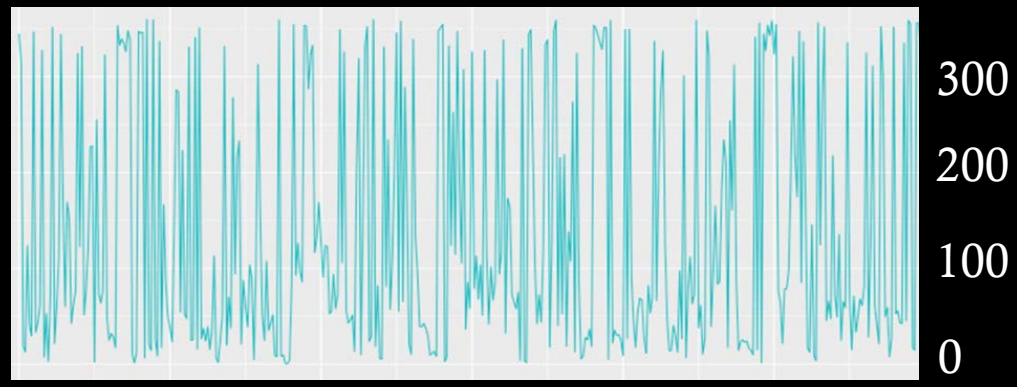








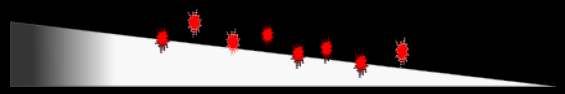




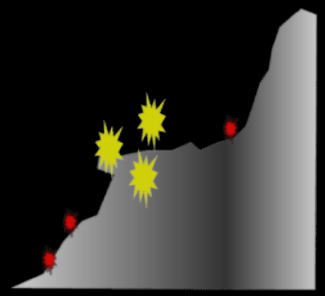
1 2 3 4 5 6

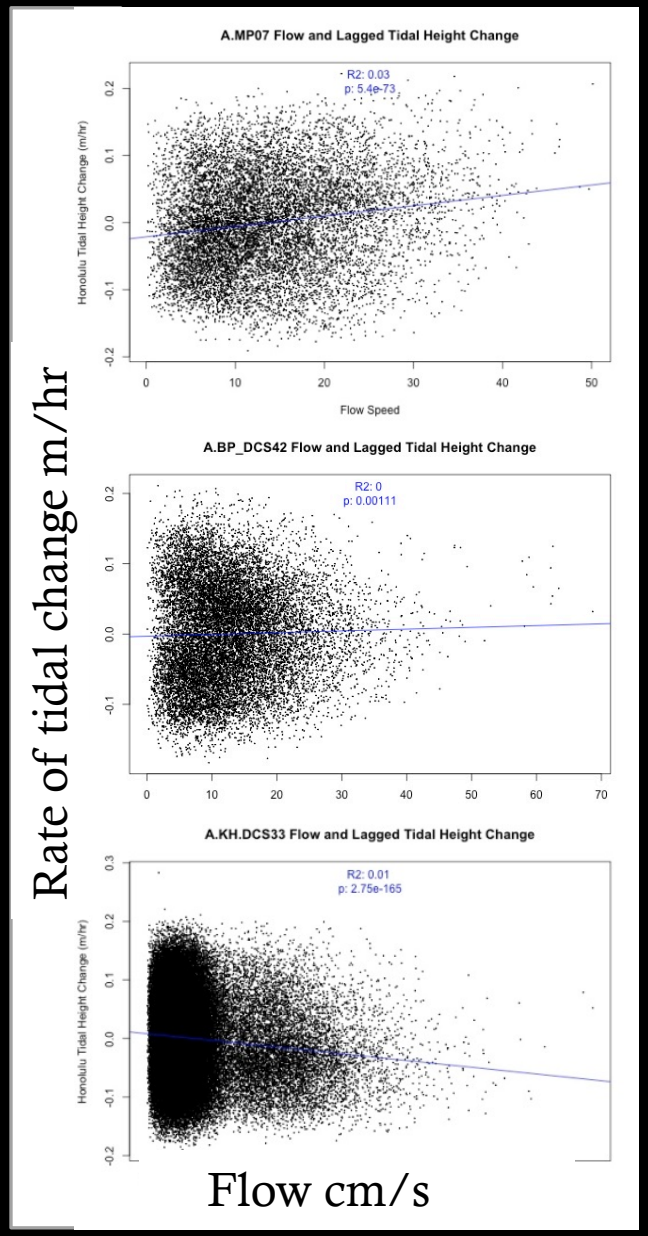
Days

Lagged tidal effects



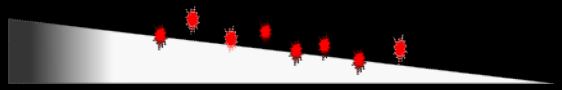
- Compared with Honolulu tide station
- Hourly rate of change in tidal height compared with flow speed.
- Reason for the different slopes?
  - Local oceanographic features
  - Bottom topography influencing tidal flow speed?
- Seasonal feature at Keahole?

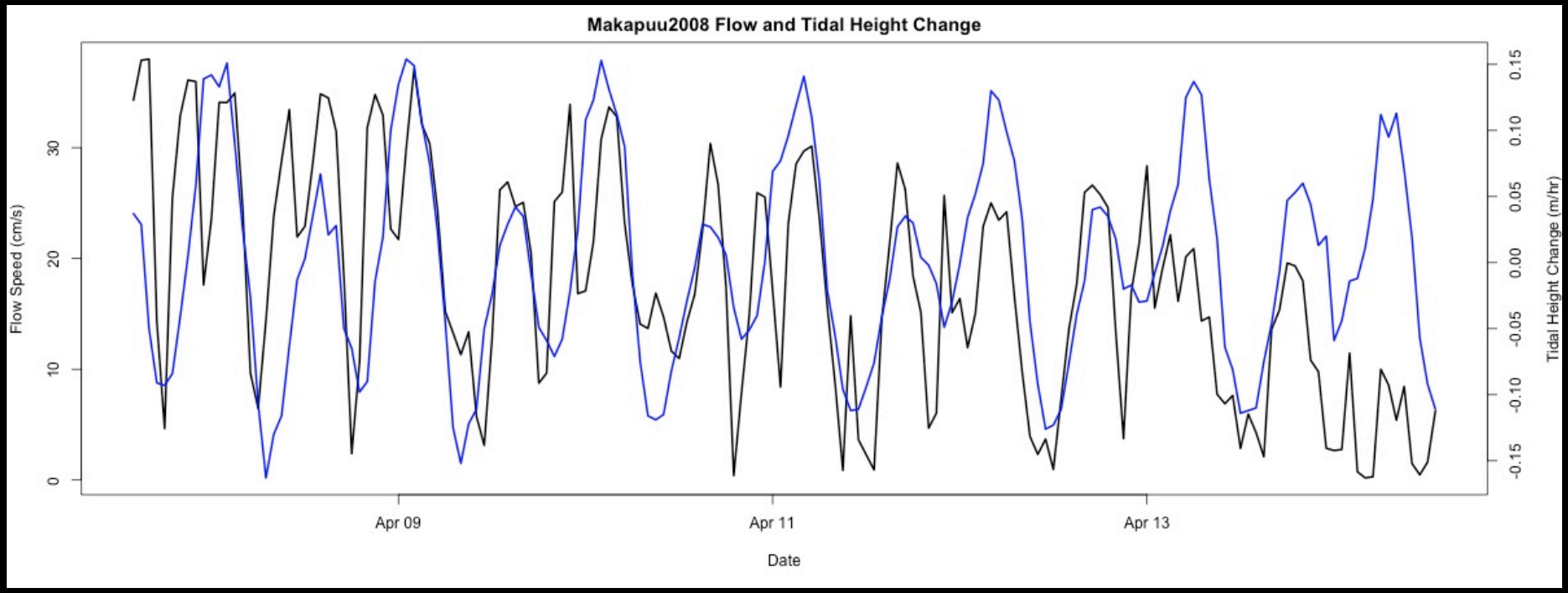




Flow in relation to tidal height

Makapuu

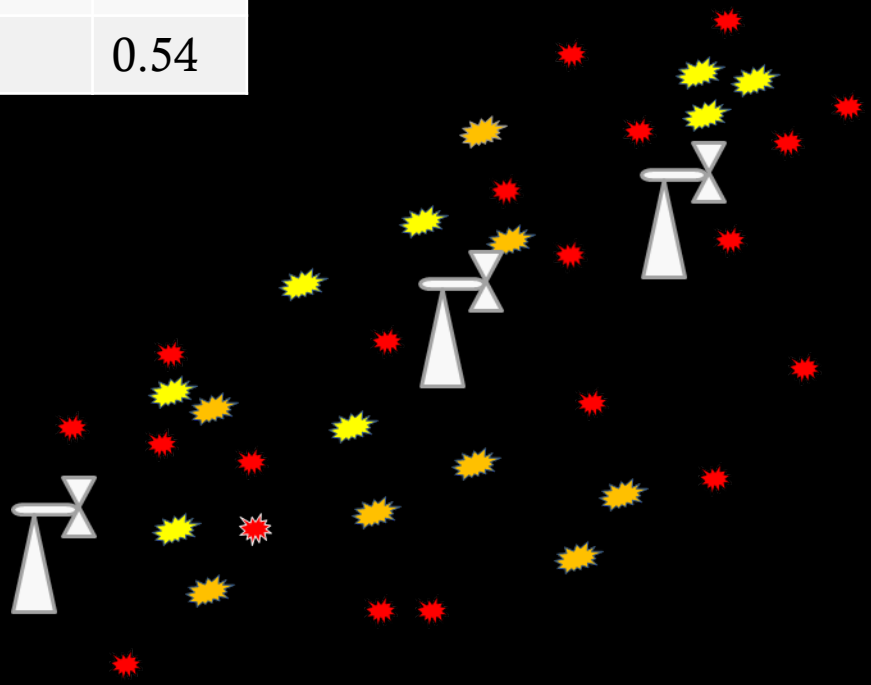




- Only Makapuu looks like it is correlated with an hourly change in tide level.
- Makapuu has the least topography to effect tidal influences

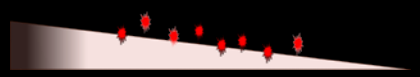
Flow (cm/s) across the patch

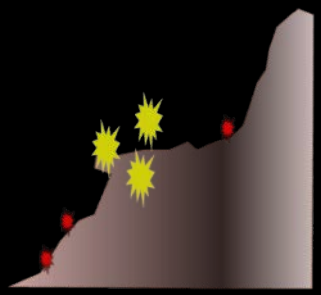
Patch	"center"	mid patch	edge
Makapuu	12.6	14.7	?
Barbers Pt.	9.6	13.5	>8.4
Keahole	4.8	2.78	0.54

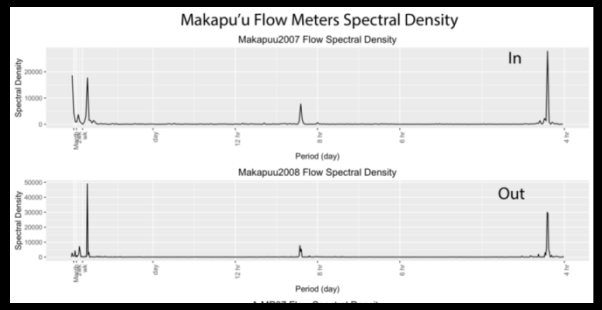


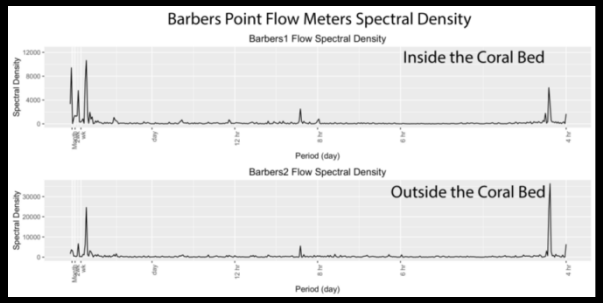
Consistent flow across the patch

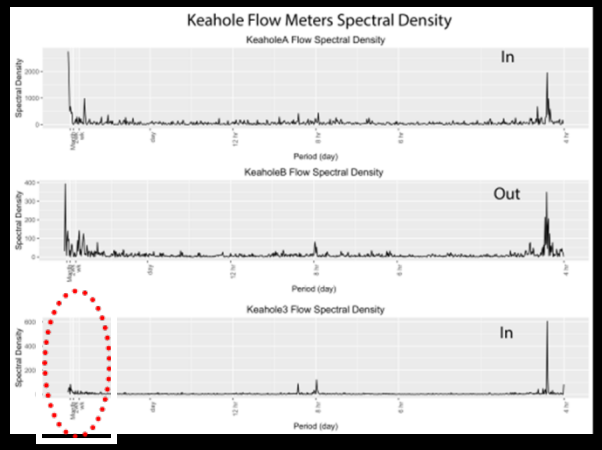
- The flow spectra is consistent within and among sites.
- No consistent difference between center (in) and edge (out) of the coral patch

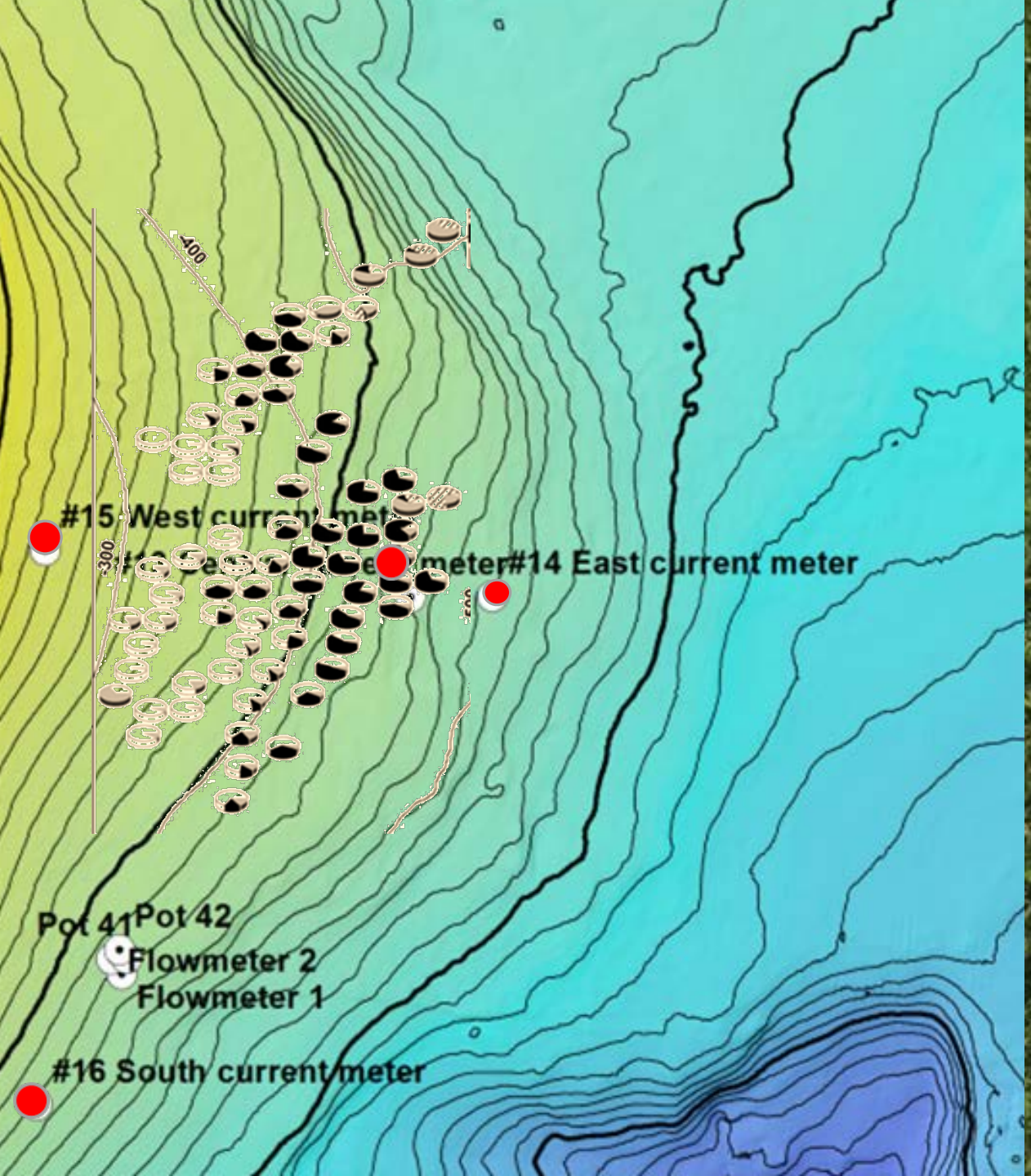






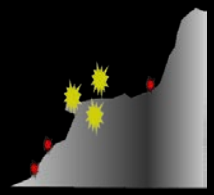


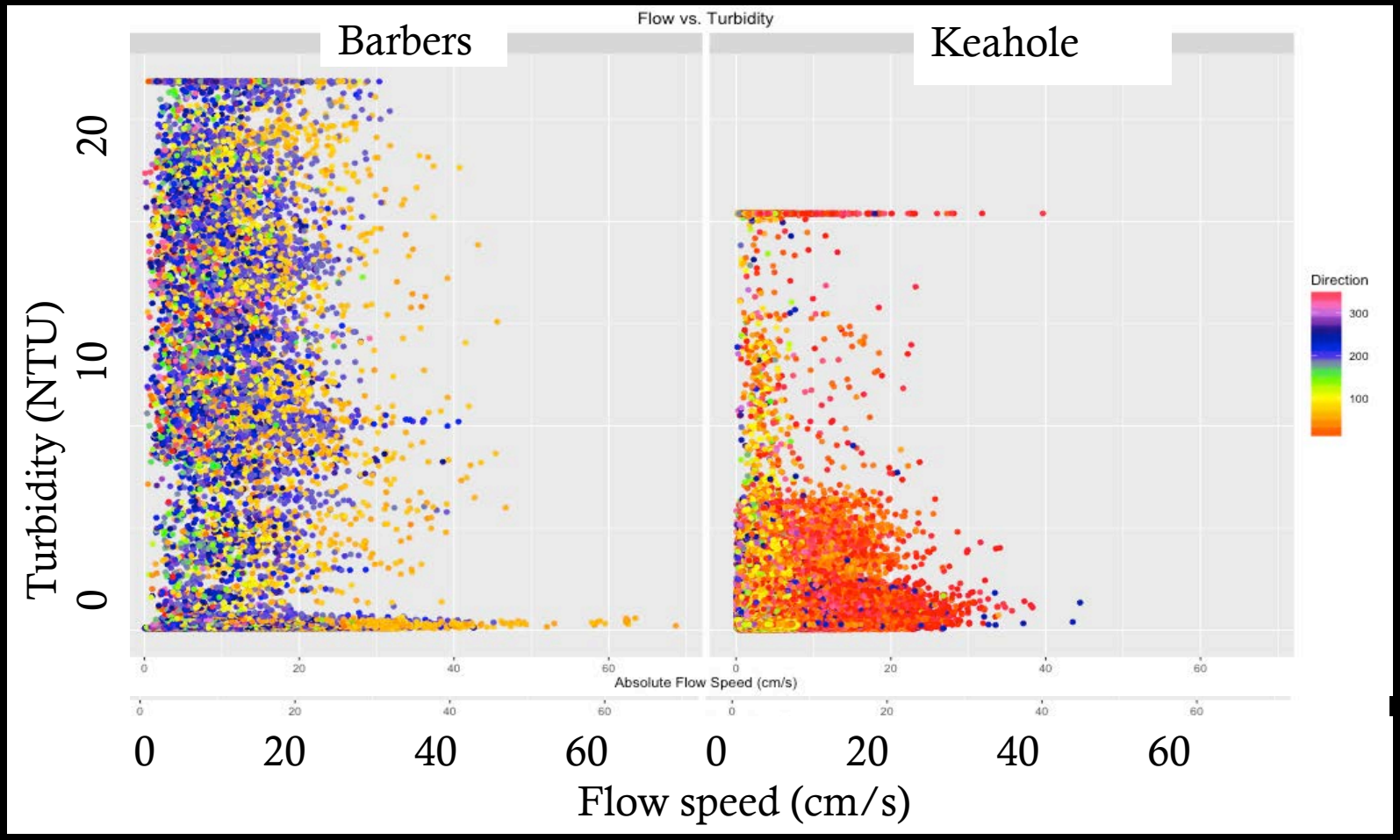



400
300
#15 West current met
#14 East current meter
Pot 41
Pot 42
Flowmeter 2
Flowmeter 1
#16 South current meter

13
14
15

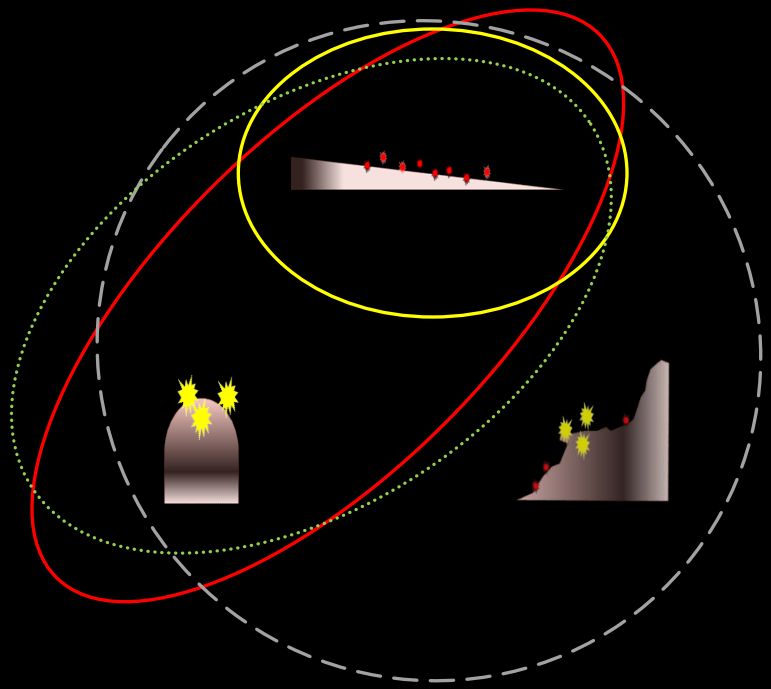
Turbidity differs between sites



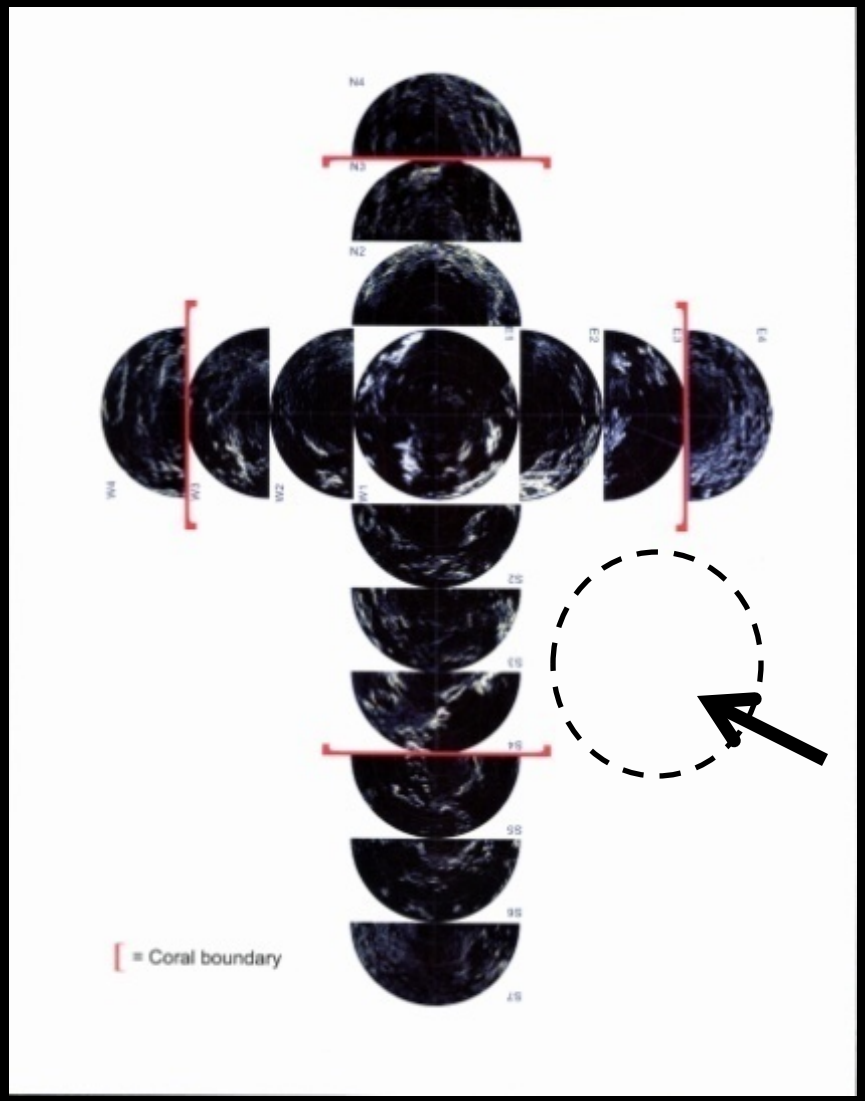


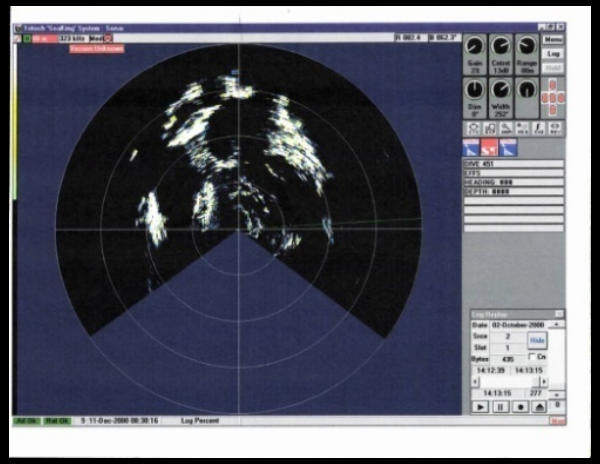
Comparing the 3 sites

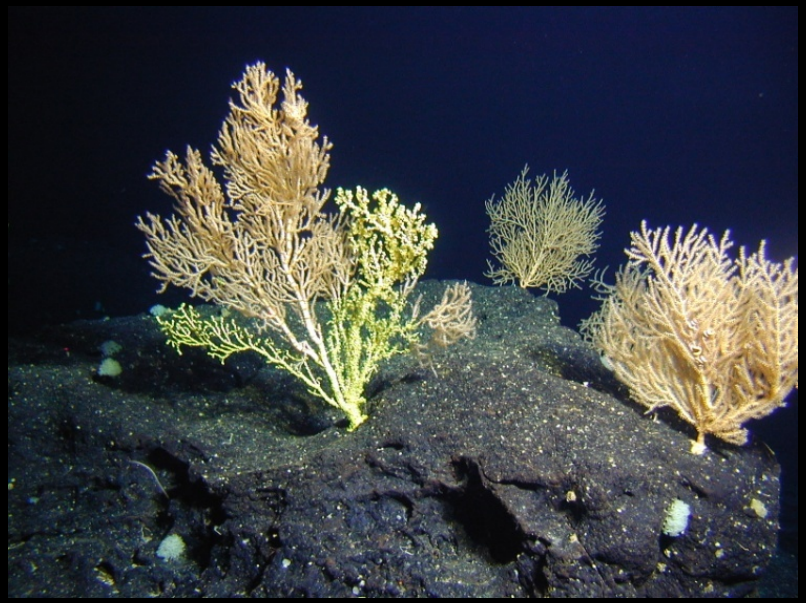
- The Makapuu and Barbers sites had appreciably higher flow environments.
- At this scale temp does change with the tide but does not correlate well with flow rate.
- Direction of flow at Makapuu site is most consistent of the three sites and also had the best correlation between tide and flow rate.
- Flowmeters placed across the coral patch indicate variability in the flow rate but were generally consistent across temporal spectra.
- Turbidity was 2-3 times greater at the Barber Pt. site which is close to the Makapuu site.



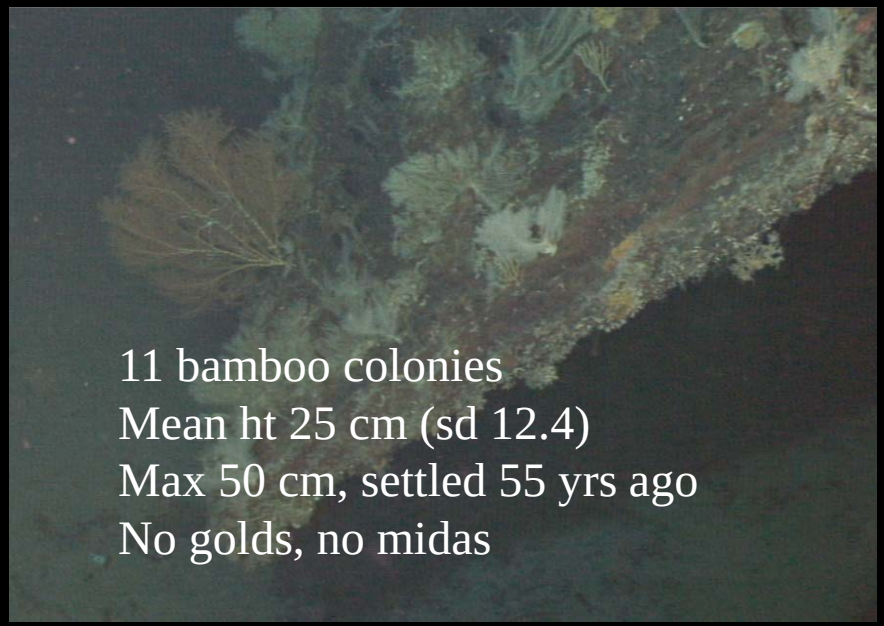
Localized recruitment?

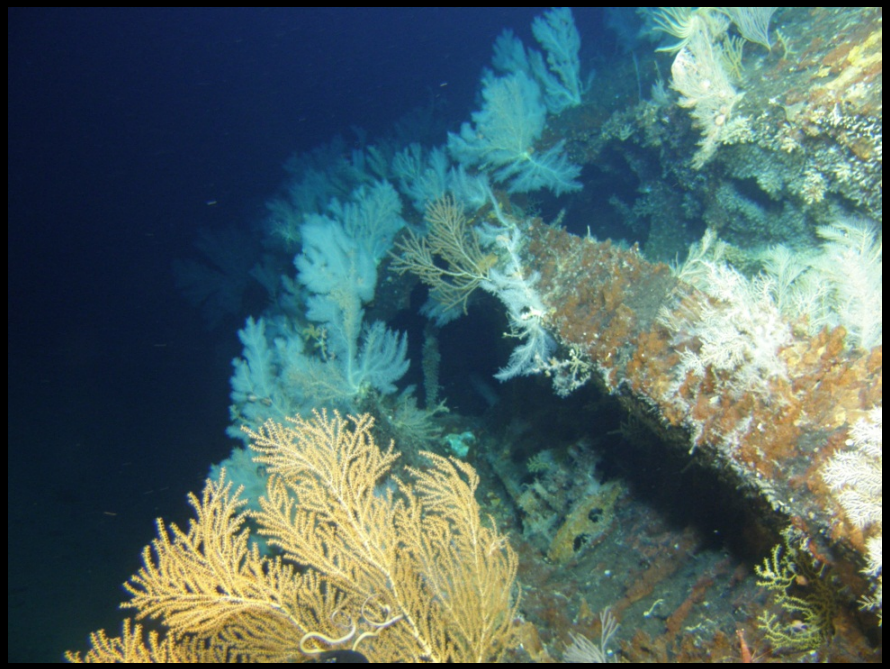






WW I S-19
scuttled 75 yrs ago


11 bamboo colonies
Mean ht 25 cm (sd 12.4)
Max 50 cm, settled 55 yrs ago
No golds, no midas



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