Impacts of Elevated CO_2 on Deep-Sea Scavengers

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Responses of organisms to regions with elevated CO_2

1. Sense and avoid the affected waters
   - Observed in some shallow water fishes and hagfish at 250 m (Tamburri and Brewer)
   - Not observed during in-situ deep-water (625 m) experiments off the US West Coast (Tamburri et al. 2000)
     - Failure to detect unfavorable chemical conditions because of steep gradient?

Responses of organisms to regions with elevated CO_2 and/or depressed pH

2) Perceive the unfavorable conditions yet remain in the affected waters
   - Irritation not sufficient to elicit response
   - Small, sessile, or sedentary organisms incapable of sufficient movement to flee

Problem - Animals capable of immediately escaping the plume do not

- Plume is not sensed or is not sufficiently irritating

Consequences:

- Animals depart prior to suffering acute toxicity
- Animals remain long enough to suffer from acute or chronic toxicity
  - Scavengers attending food-falls
    - Potentially leading to a Mortality Sink
      - » Analogous to ghost fishing

The “Mortality Sink” Hypothesis

Widely ranging scavengers attracted to odor plumes from animals killed by waters enriched with CO_2 will suffer the same fate

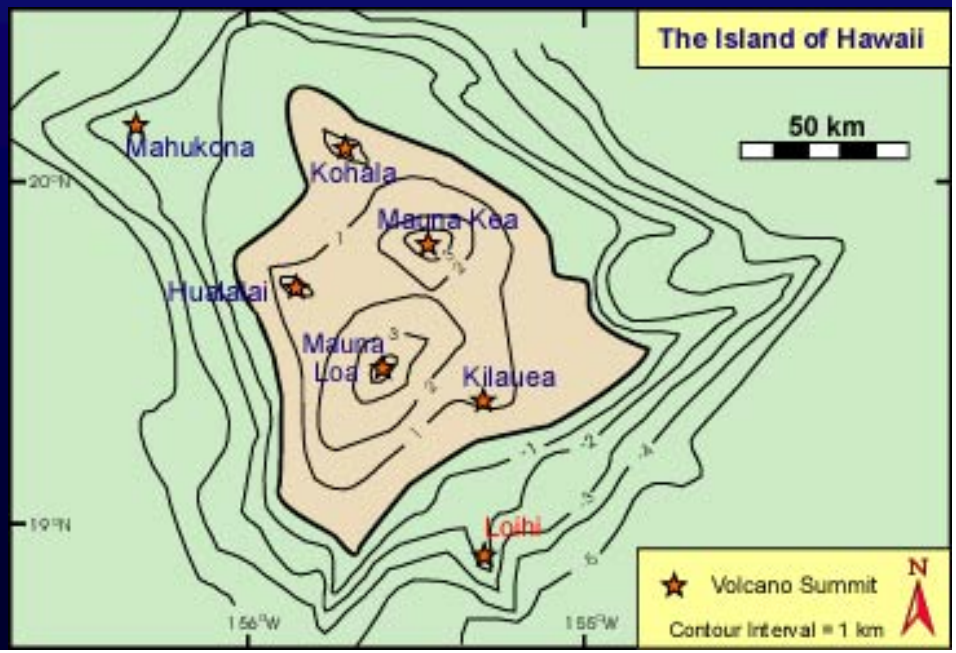
- Will lead to a disruption in ecosystem functioning, potentially over a large scale

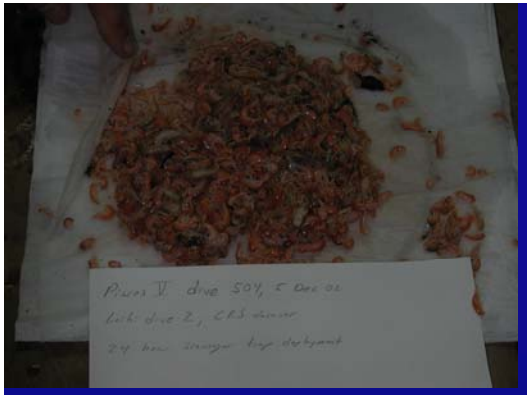
Alteration of Ecosystem Function

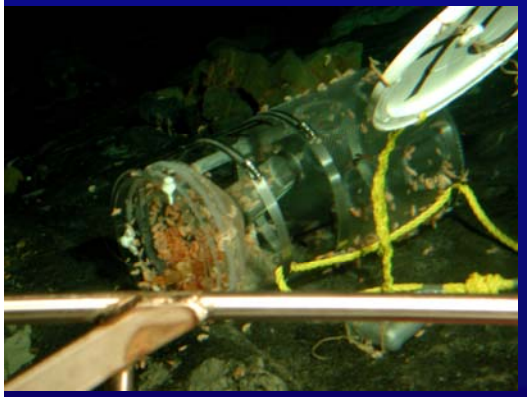
- Accumulation of organic detritus ranging from wood to fecal pellets to carcasses of large fishes and marine mammals may result if:
  - in-situ detritivores including polychaete worms, gastropods, and crustaceans are killed
  - opportunistic species such as shipworms fail to recruit
  - and mobile scavengers including amphipods, hagfishes, and sharks are unable to enter affected waters.

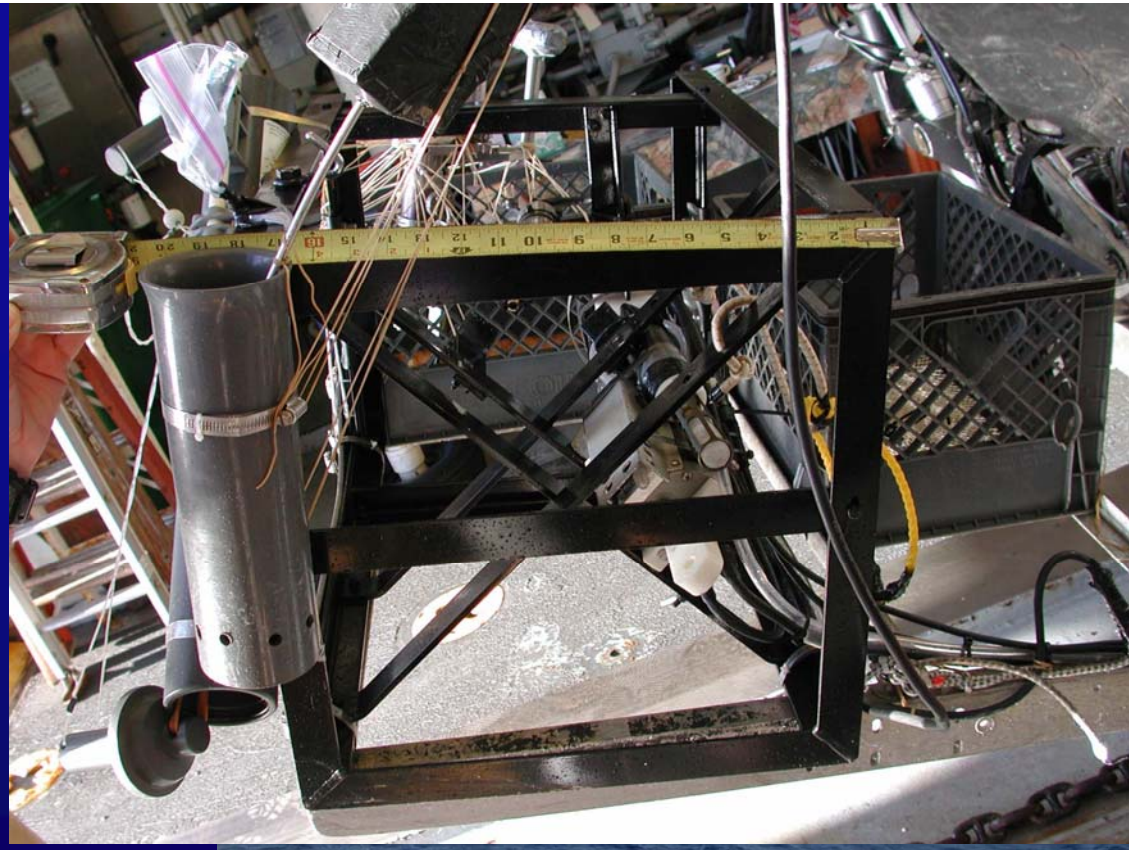
Loihi Seamount

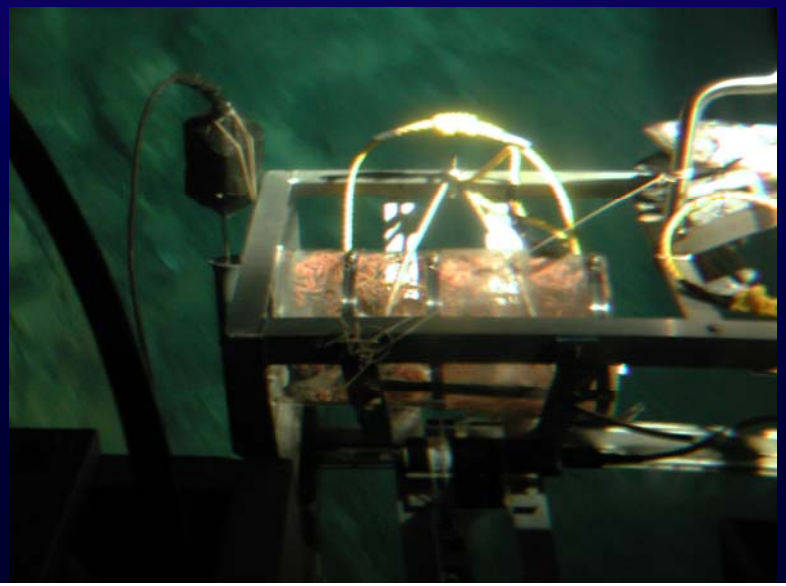
- Continuous venting of large volumes of CO_2 enriched hydrothermal fluids
- located about 30 km south of the island of Hawaii
- Most vents are low temperature (<30° C)



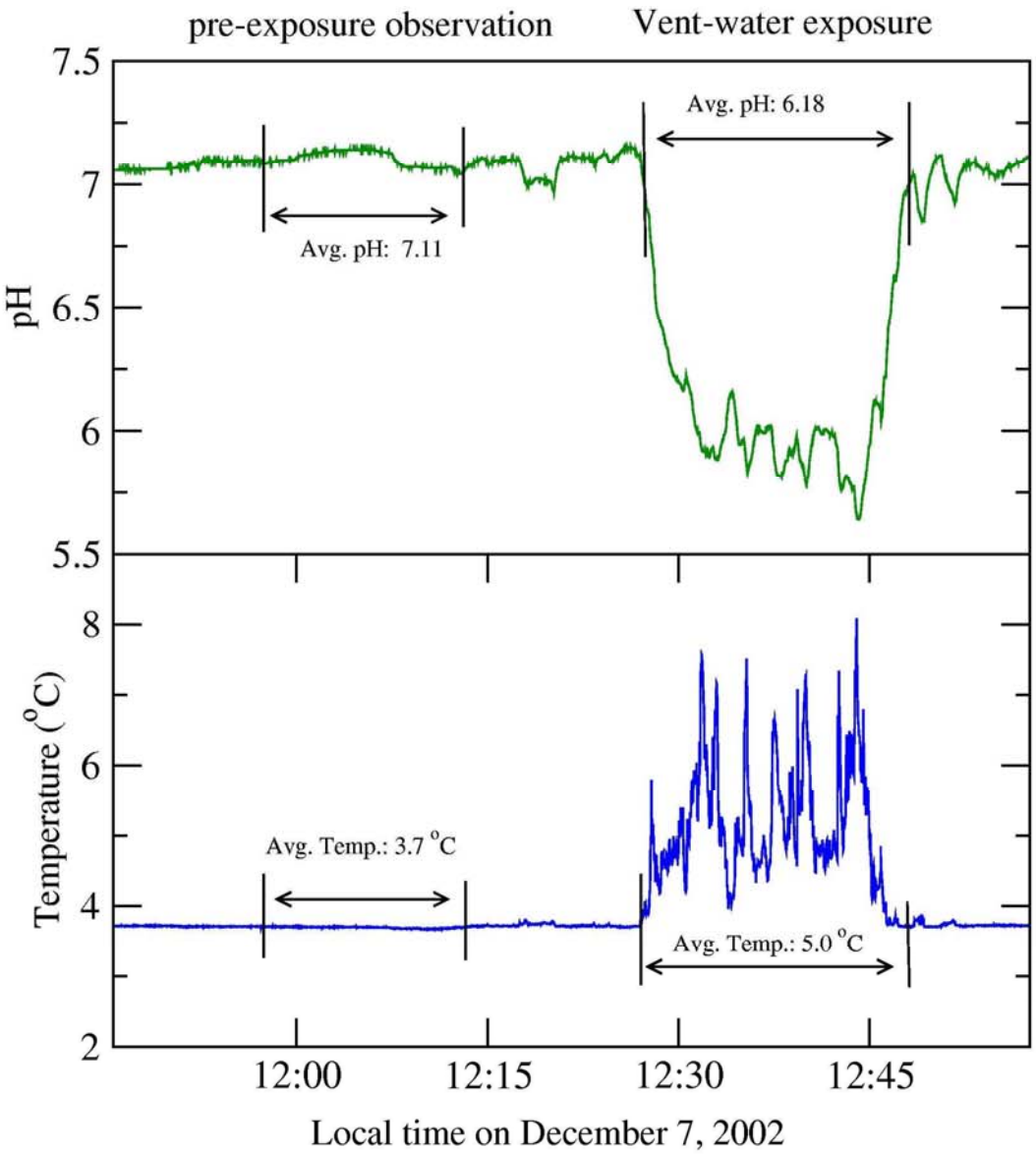

Pisces V. dive 504, 5 Dec 02

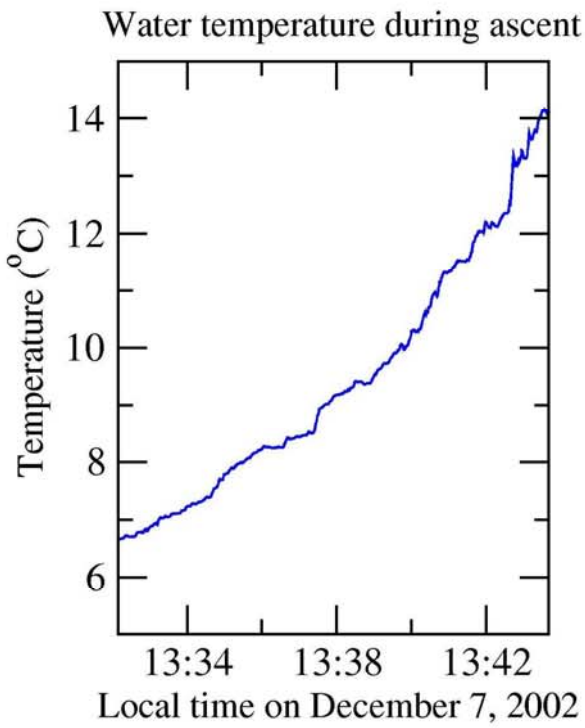






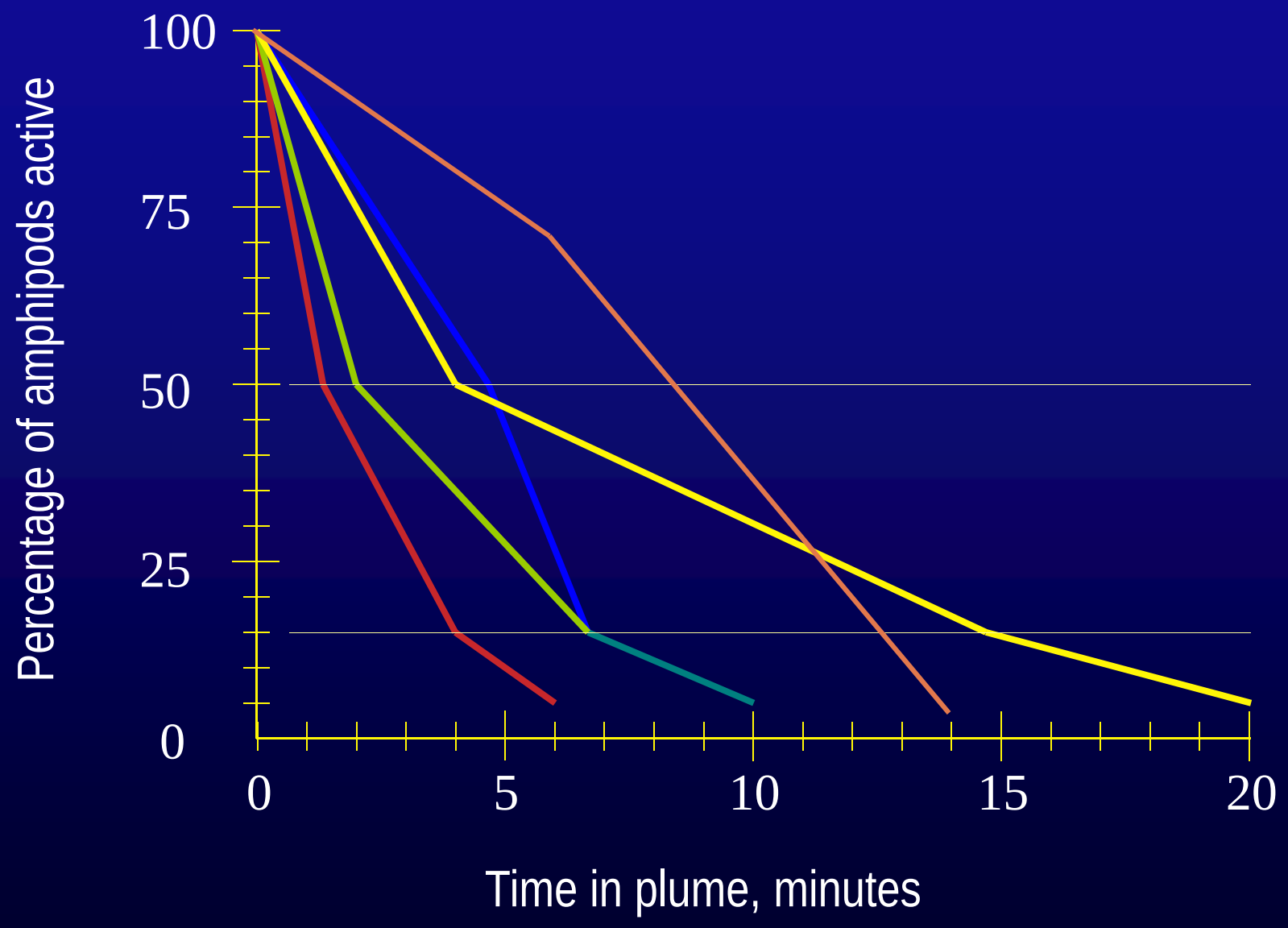
Amphipod Exposure Experiment, PV506



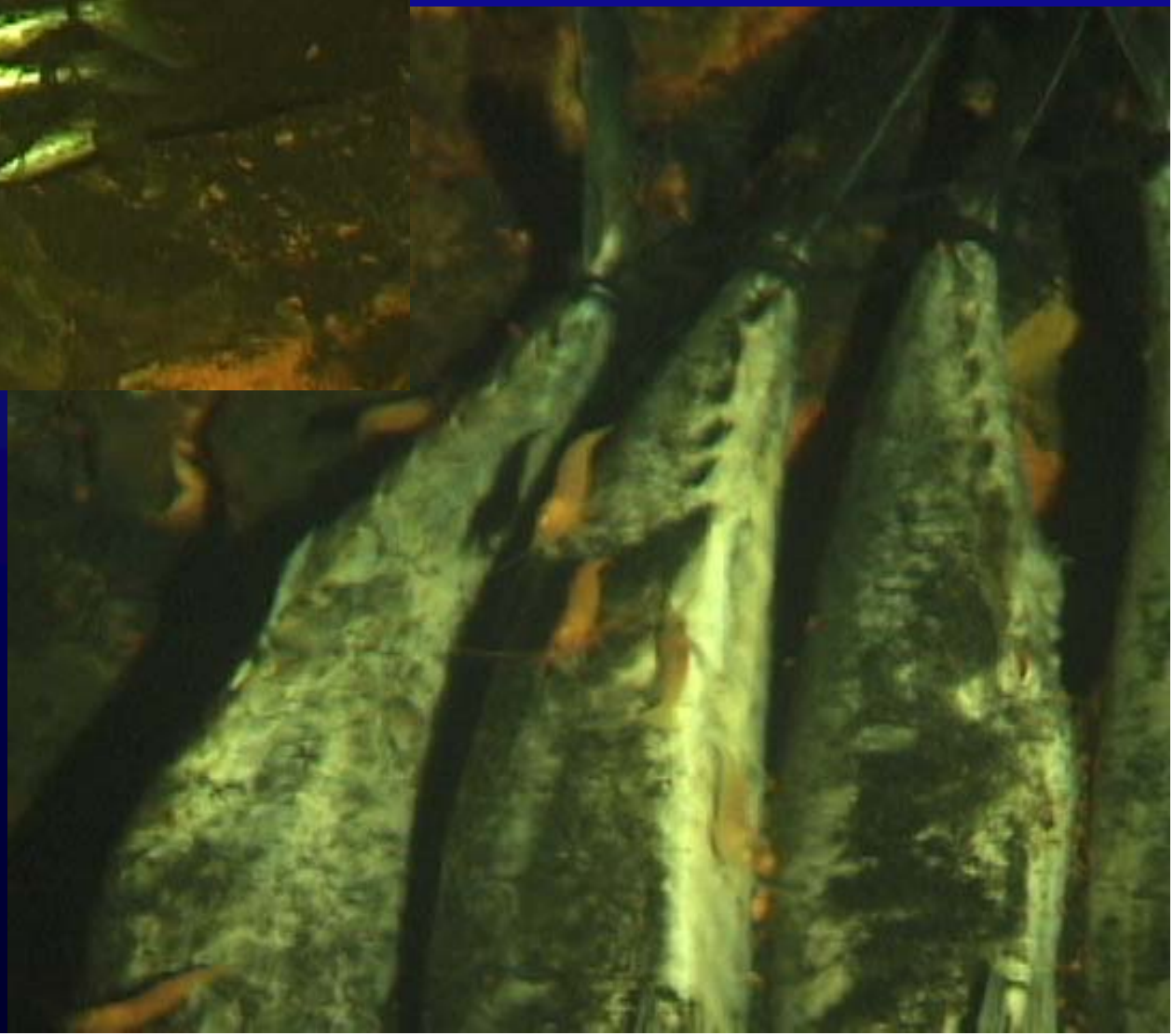


M. Eek, 2003

Activity level of amphipods following exposure to CO_2 rich plume

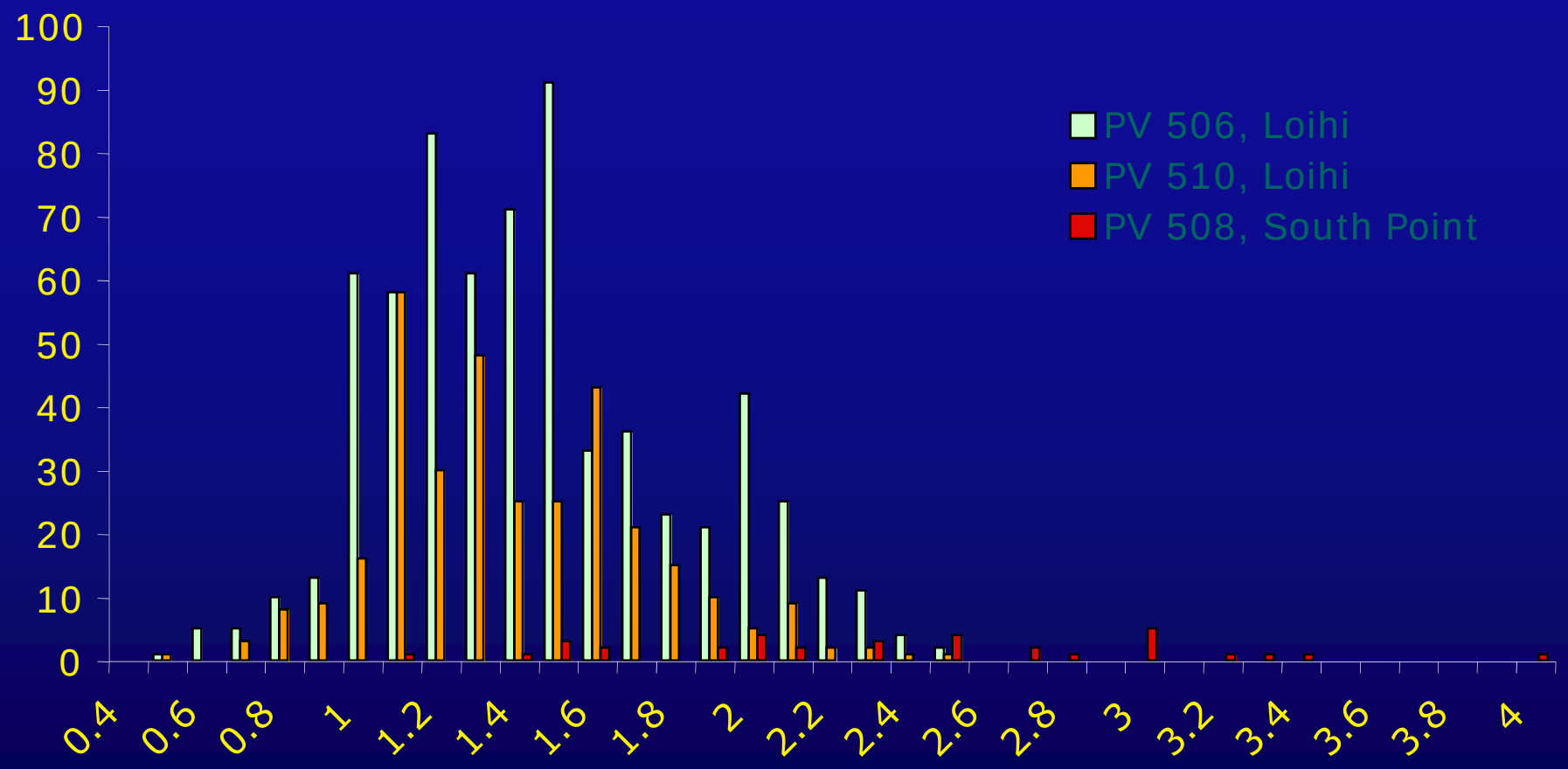


In vent 7 days

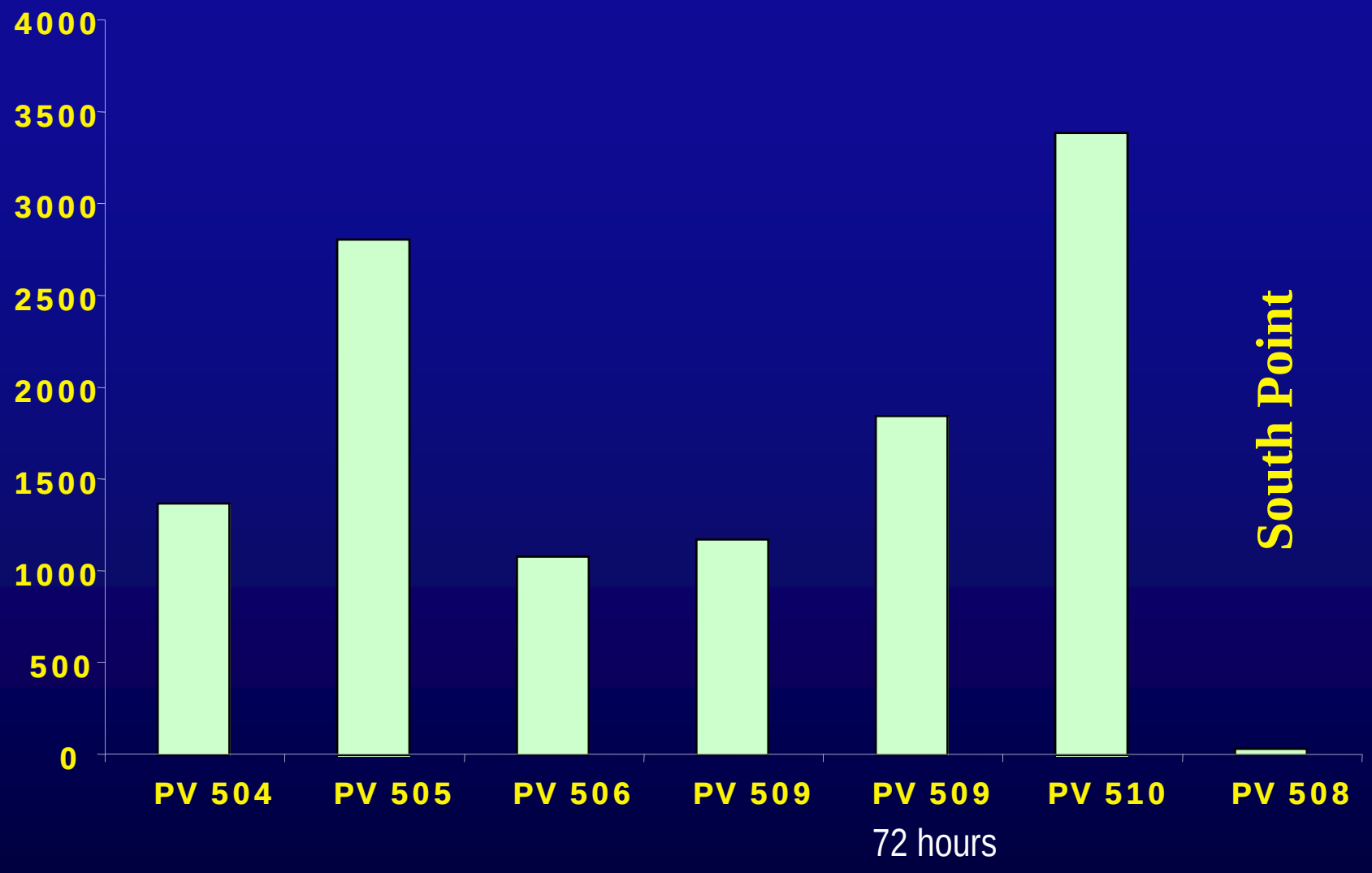


In vent 5 days

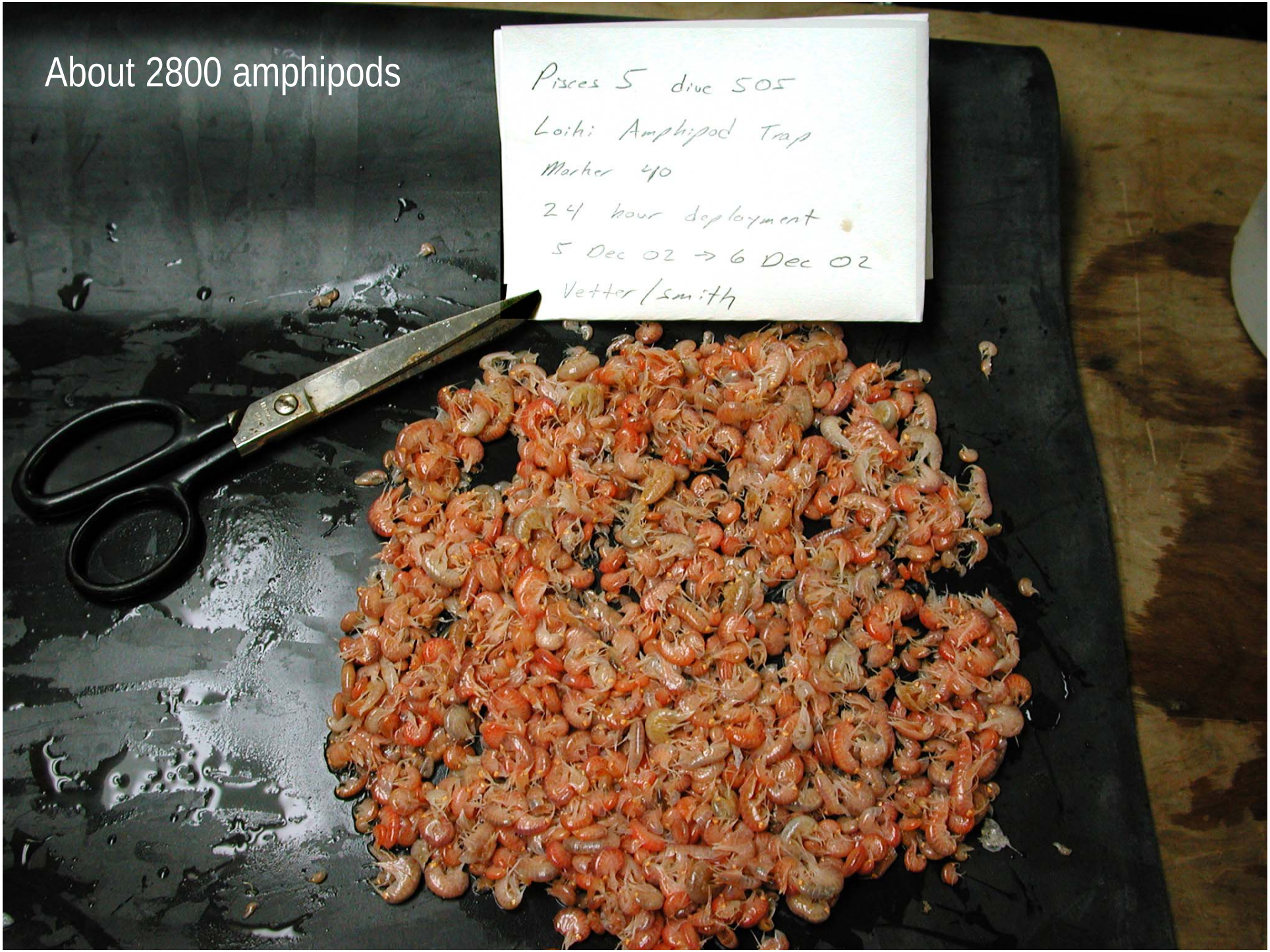
bresiliid shrimp,
Opaepele loihi



Size-frequency of amphipods trapped at Loihi and South Point



Numbers of Amphipods Trapped, 24 hours


About 2800 amphipods
Pisces 5 dive 505
Loihi Amphipod Trap
Marker 40
24 hour deployment
5 Dec 02 → 6 Dec 02
Vetter/Smith

Temperature

- During Experiment: 4 - 8°C, average 5.0°C
- On Ascent:
  - Most amphipods active at 10°C
  - Most amphipods inactive at 12°C

- Lysianassid amphipods at Loihi sensed and avoided impacted waters
  - No evidence of mortality sink
  - Indicates potential failure of ecosystem function
- Presence of bresiliid shrimp
  - CO_2 tolerant ecological equivalents may mitigate loss of ecosystem function
- Presence of large numbers of Amphipods and Synaphobranchid eels
  - Food source:
    - vent production
    - high seamount productivity
    - Animals disabled by vent emissions

Thanks to Ric Coffin, Keith Johnson, Magnus Eek, Eric Adams, NRL

Future Efforts at Loihi

- Larval recruitment
- Water column impacts
- Reduced temperature plume experiments
- Larger, longer term baiting in plume
- Microcosm experiments using liquid CO_2
  - Gradient and controlled exposure