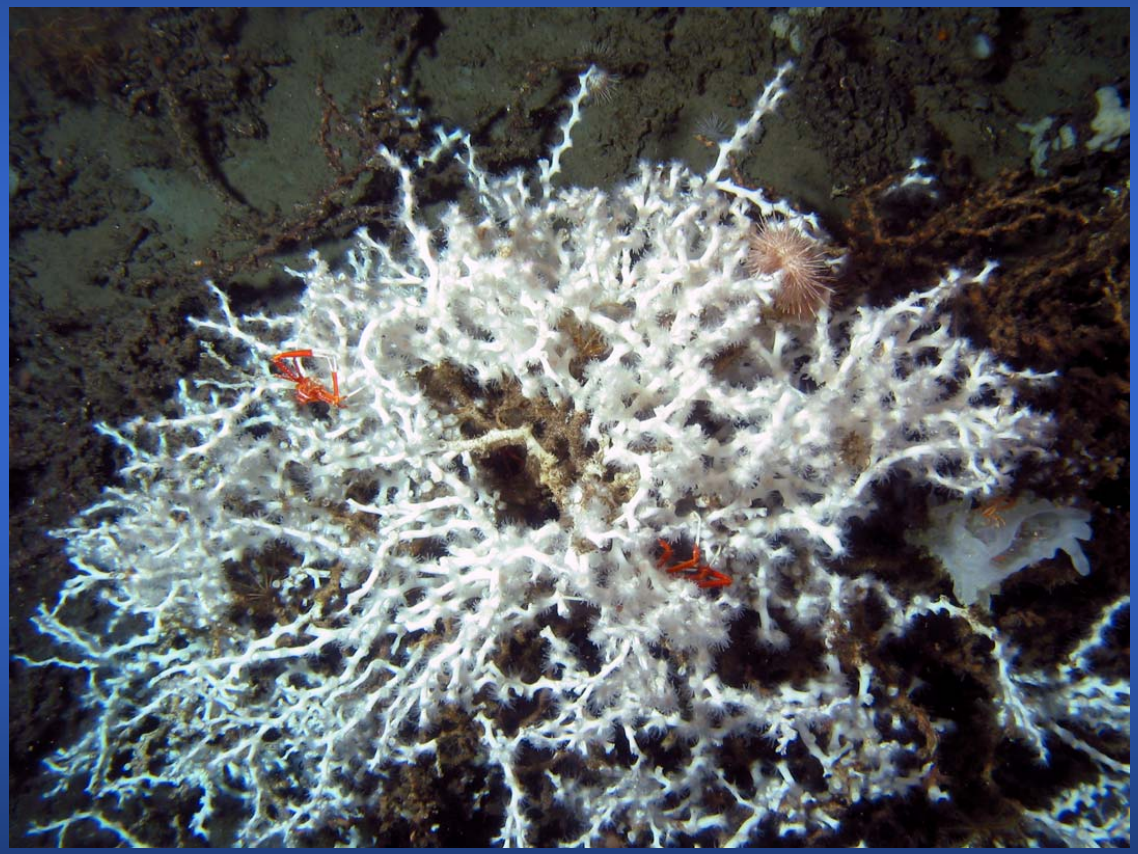
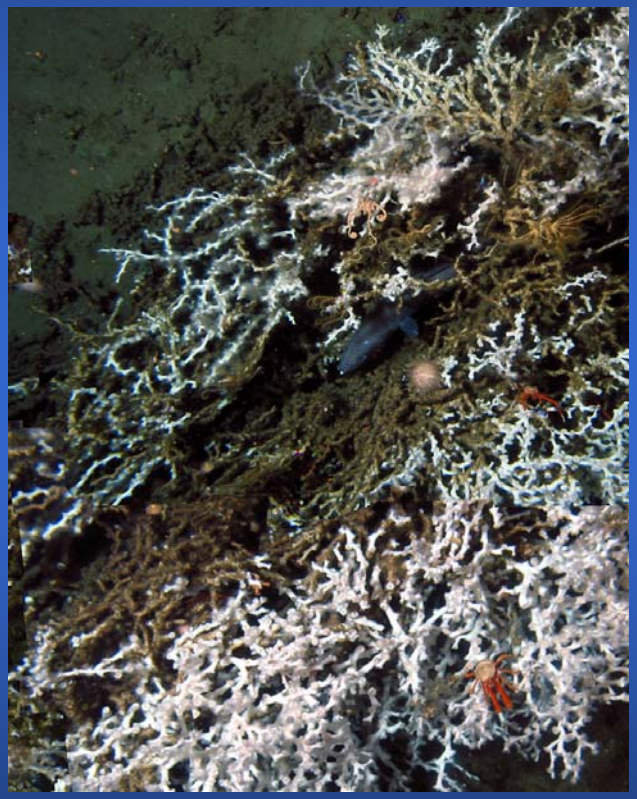
Overview of “Lophelia I” and Thoughts for “Lophelia II”





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Objective:

To better understand *Lophelia pertusa* distribution, biology, and ecology in the Gulf of Mexico

Approach

- Find and characterize multiple sites with significant *Lophelia pertusa* coverage
- Characterize the distribution of *L. pertusa*, of other corals and of fauna associated with *L. pertusa*
- Identify trophic relations among fauna and relation to seep primary productivity
- Study physiological ecology of *L. pertusa* with field and laboratory experiments
- Examine larval distribution potential for *L. pertusa*

Limiting Factors

- Few “significant” sites studied
- <u>Navigation and “map” quality</u>
- “Seasonality” of sampling
  - Wrong season for coral spawning
    - No larvae
  - Limited data on temporal variation
  - Limited data on most mobile “visitors”

Result Overview: Physical Oceanography/Models

- Current and temperature variability along the northern Gulf of Mexico continental shelf slope is dominated by the passage of oceanic mesoscale features.
- Currents at the study sites fluctuate dominantly in the along-isobath direction and models indicate that larvae will be primarily advected in similar directions.
- Significant seasonal variability of riverine input and surface primary productivity occurs over the study sites.

Result Overview: General

- The largest current velocity measured over an 11-month period (2.7m above the seafloor at GC234 (511m depth)) was 44 cm/s.
- Temperatures at the study sites varied up to 4° within a site and from 6.8–13°C at all sites over one year.
- No significant hydrocarbon load was detected in the water column above the coral aggregations.
- Biggest aggregations associated with sites with coarser sediments.
- At sites with limited *L. pertusa* development, the corals occurred on edges of local topographic highs.

Result Overview: General

- Best developed *L. pertusa* areas were not associated with currently active seepage although old tubeworm aggregations were present at the same site.
- Sedimentation was highest in sites with most corals and not correlated with *L. pertusa* distribution on small scales.
- Zooplankton density (as measured in traps) was generally low and not correlated with coral distribution on small scales but highest at high density coral site.
- Some other corals, notably the gorgonian *Callogorgia americana* and black corals (*Leiopathes* spp) formed substantial aggregations in some areas and (along with others) are potentially important foundation species.

Result Overview: Community Ecology

- A total of at least other 68 species were collected with *L. pertusa*, (but species effort curve is not near a plateau)
- Mosaics and transects identified seven *L. pertusa* associates not found in collections and also a variety of other faunal associations between other corals and mobile megafauna
- Most associates are known from background fauna; three are potentially endemic to *L. pertusa* thickets and six are very common in tubeworm aggregations ("seep endemics")
- Bray curtis dissimilarity indices and MDS analyses:
  - group *L. pertusa* community collections by site
  - support % of dead skeleton as important in community structure
  - emphasize differences to tubeworm communities

Result Overview: Trophic Relations & Stable Isotopes

- Significant dependence on seep primary production is the rare exception, although it is present in some species of coral associates.
- The food web is dominated by generalists (that feed within a single trophic level): few tight trophic relations exist between individual species.
- Only *Coralliophila* sp may feed directly on *L. pertusa.*
- There is no indication of a direct nutritional tie to seepage in *L. pertusa* tissue or skeleton.
- There was no change in skeleton carbonate $\partial^{13}C$ from colony base to tip, suggesting settlement does not occur during active seepage.

Result Overview: Growth Studies

- It worked!
  - *In-situ* staining
  - Shipboard staining and redeployment
- No significant differences between *in-situ* and shipboard stained rates (growing *in situ*)
- No significant differences between corals placed among other corals and corals placed on bare substrate
  - No significant difference in survival (~90%)
  - Only slight difference in growth rates (~1mm/month per branch)
  - No significant difference in new polyps (~3 new polyps/ fragment/14 months)

Recruitment apparently not space-limited

Result Overview: *L. pertusa* Laboratory Studies

- Histological examination suggests that spawning is not synchronous and most likely occurs in October.
- *L. pertusa* can survive short-term exposure to 15°C (24 hour), but exposures on the scale of seven days results in 20% mortality. At 20°C there was 70% morality after seven days.
- *L. pertusa* demonstrated relatively high tolerance to sedimentation in the lab, with >50% survival after two weeks of exposure to 100mg/l or two days complete burial with GOM sediment. However, mortality increased rapidily with higher loads or burial times.

Future Directions

- We need a better understanding of Gulf Wide distribution of corals and how to detect/ predict these from surface derived data and oceanographic models.
  - This will require another effort of MMS data review perhaps with consideration of current models to select target sites, followed with remote ground-truthing methods (imaging).

Future Directions

- We need to know the depth and geographic distribution of soft- and hard-coral foundation species in the GOM
- We need a better understanding of communities associated with all foundation species
  - These will require *in-situ* work with ROVs or Manned Submersibles on new sites

Future Directions

- We need much better understanding of factors affecting local distribution of live corals within a site (scale of meters to kilometers)
- We need a better understanding of environmental requirements for rich hard bottom communities in the GOM
  - These will require state of the art navigation, survey and mapping associated with any *in-situ* work and some long term monitoring of selected sites

Future Directions

***In-situ* experimentation, laboratory analyses, and experiments should complement the *in-situ* surveys and collections to increase confidence in correlations and their predictive value.**

- **Growth studies can be conducted *in situ* to compare growth rates between sites, between areas, and (with short distance transplants) under different *in-situ* environmental conditions.**

Future Directions

***In-situ* experimentation, laboratory analyses and experiments should complement the *in-situ* surveys and collections to increase confidence in correlations and their predictive value.**

- **Laboratory studies with live corals can be used to define their tolerance to a variety of potential environmental and anthropogenic stressors (eg, hydro-carbons, sulfide, drilling fluids, etc.). These should include acclimation studies.**

Future Directions

***In-situ* experimentation, laboratory analyses and experiments should complement the *in-situ* surveys and collections to increase confidence in correlations and their predictive value.**

- **Larval life cycle studies can help constrain the dispersal models and larval tolerance studies may illuminate sensitivities not present in established (adult) colonies.**

Future Directions

***In-situ* experimentation, laboratory analyses and experiments should complement the *in-situ* surveys and collections to increase confidence in correlations and their predictive value**

- **Genetic analyses are essential to understand species distributions and the relations between populations.**

Future Directions

- Monitoring (over months to years) of physical and chemical environmental parameters, as well as larger mobile fauna, will provide important additional information on deep GOM hard ground communities that cannot be obtained by other means.

Future Directions

- Models should be employed both to plan studies (inform site selection for example), and interpret data (larval dispersal and metapopulation models for example)