MMS Information Transfer Meeting: Effects of Subsea Processing on Deepwater Environments in the Gulf of Mexico

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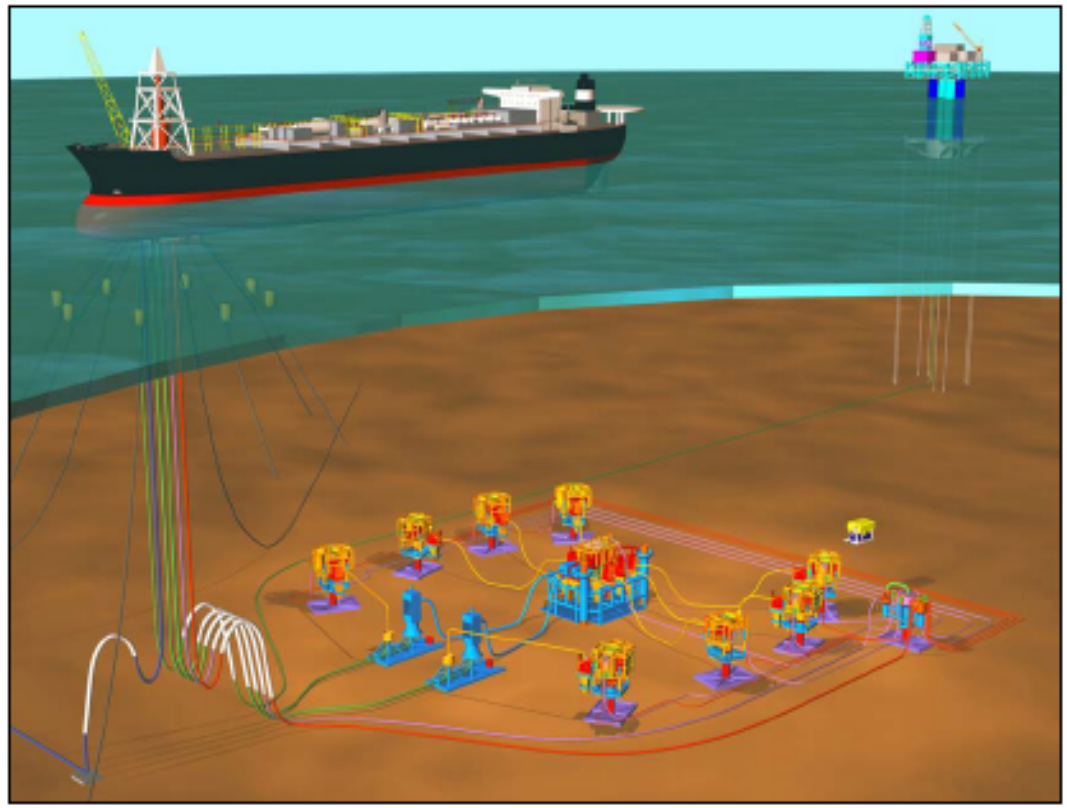


Purpose of the Study

- Provide information to support management decisions
- Compile information on subsea technology
- Summarize relevant environmental studies
- Identify and acquire environmental data
- Extrapolate effects from known technology
- Initiate exchange of information between MMS and industry

Deepwater/Subsea Production (>1000 feet)

- More production capacity from deep-water reserves than Saudi Arabia or Russia …11.9 million bbl/day
- Deepwater production is expected to account for 40% of U.S. production by 2010
- Many discoveries > 7,000 ft

Technological Challenges to Deepsea Production

- Pressure differential between seabed and platform
- Hydrate and wax formation
- Slugging, uneven flow in riser
- Internal pipeline corrosion

Subsea Developments

- **Multiphase flowlines provide access to new reserves**
- **Subsea processing is necessary to effectively deplete the reservoir**
- **Seafloor location provides several advantages:**
  - Improved reservoir yields
  - Reduced weight on surface production facilities (FPSO, Spar, TLP)
  - Improved flow characteristics
  - Hydrate prevention
  - Reduced number of surface facilities

Scott et al. 2004

Technical Project Tasks

- Task 1: Technical Information Collection
- Task 2: Environmental Information Collection
- Task 3: Identify Prospective Technologies
- Task 4: Identify Additional Data Needs
- Task 5: Evaluation and Reporting

Task 1 and 2: Data Acquisition

- **Literature Review**
  - Peer reviewed literature
  - OTC conference proceedings
  - MMS reports
  - EIS

  - 50 key documents
    - 29 documents on technology
    - 5 documents on baseline environmental conditions
    - 2 documents discuss potential environmental effects
- **Technical Experts**
- **Industry Contributions**

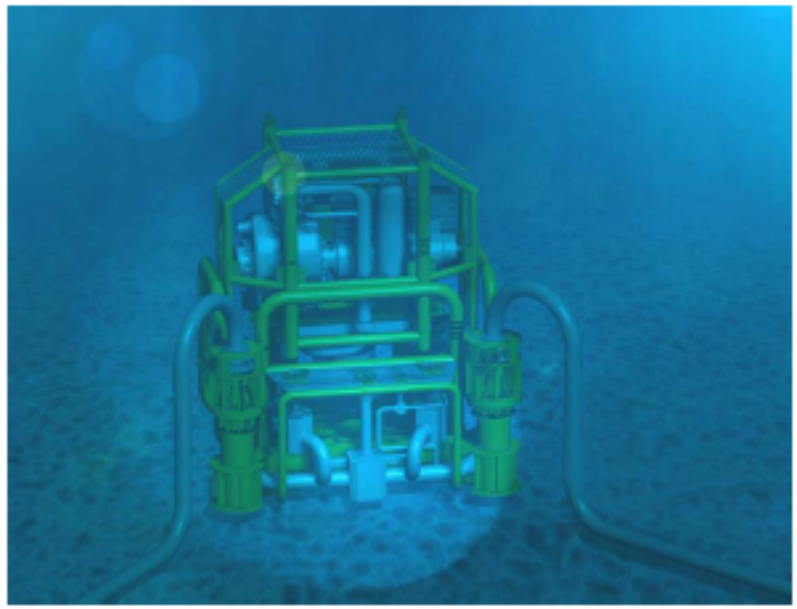
Task 1: Classification of Subsea Processing Systems

Classification	Characteristic	Equipment	Water Disposal	Sand Disposal
Type 1	Multiphase Mixture is Handled Directly	Multiphase Pump	None...Pumped with Other Produced Fluids	None...Pumped with Other Produced Fluids
Type 2	Partial Separation of the Production Stream	Separator and Multiphase Pump; possible use of Wet-Gas Compressor	Possible Re-Injection of partial water stream, i.e. "free" water	None..Pumped with Liquid Stream
Type 3	Complete Separation of the Production Stream at Subsea Conditions	Separator and Scrubber Stages w/ Single or Multiphase Pump; possible use of Gas Compressor	Re-Injection/Disposal of Majority of Water Stream	Must be addressed
Type 4	Export Pipeline Quality Oil & Gas	Multi-Stage Separator and Fluid Treatment; single-phase pumps and compressors	Re-Injection/Disposal of Entire Water Stream	Must be addressed

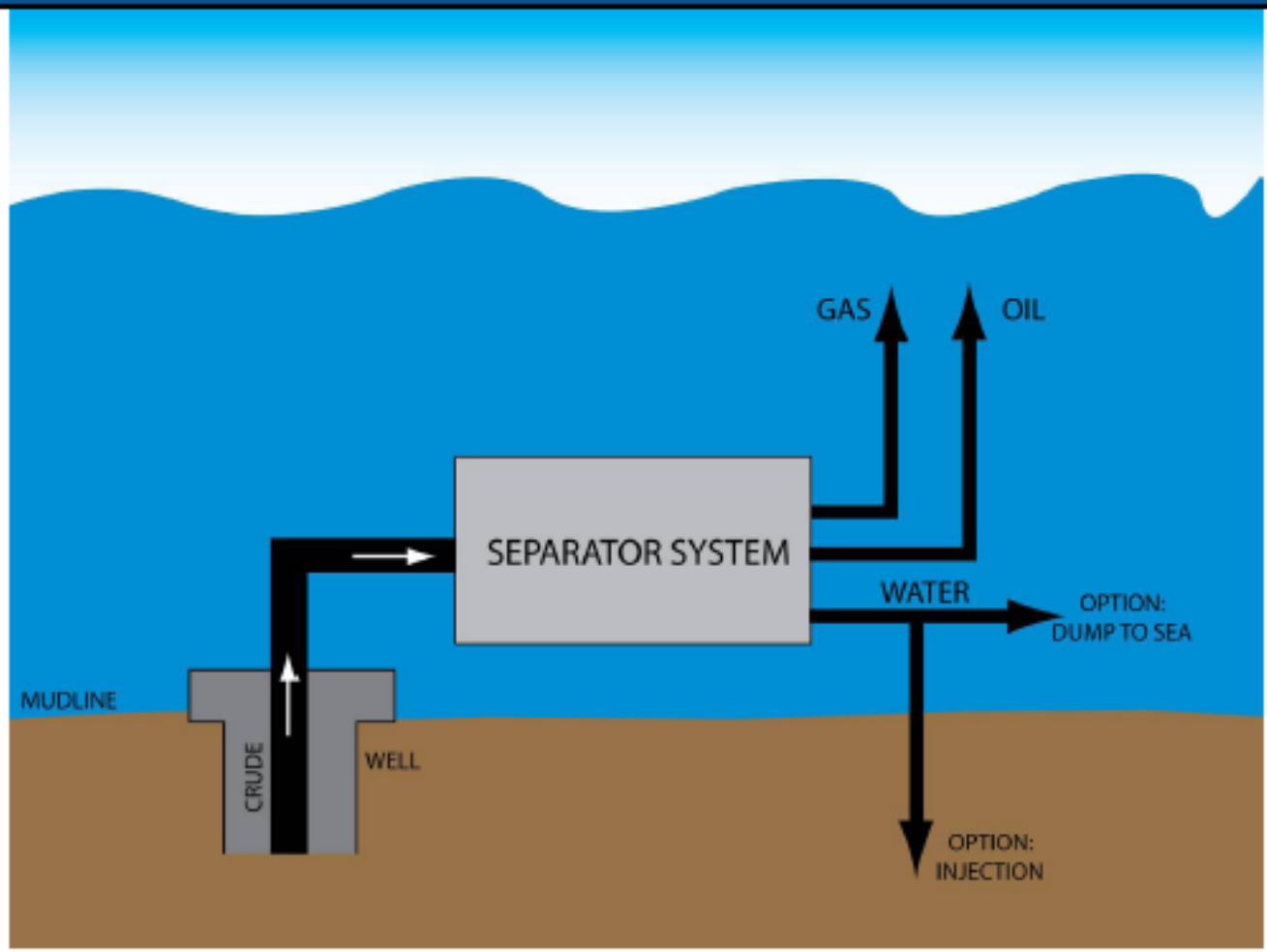
Scott et al. 2004

Type 1 Subsea Processing – Mulitphase Boosting

- Hess Ceiba Field – West Africa
- Santos Mutineer/Exeter Field - Western Australia
- CNRL Lyell Field – North Sea
- Petrobras Marlim Field – Brazil

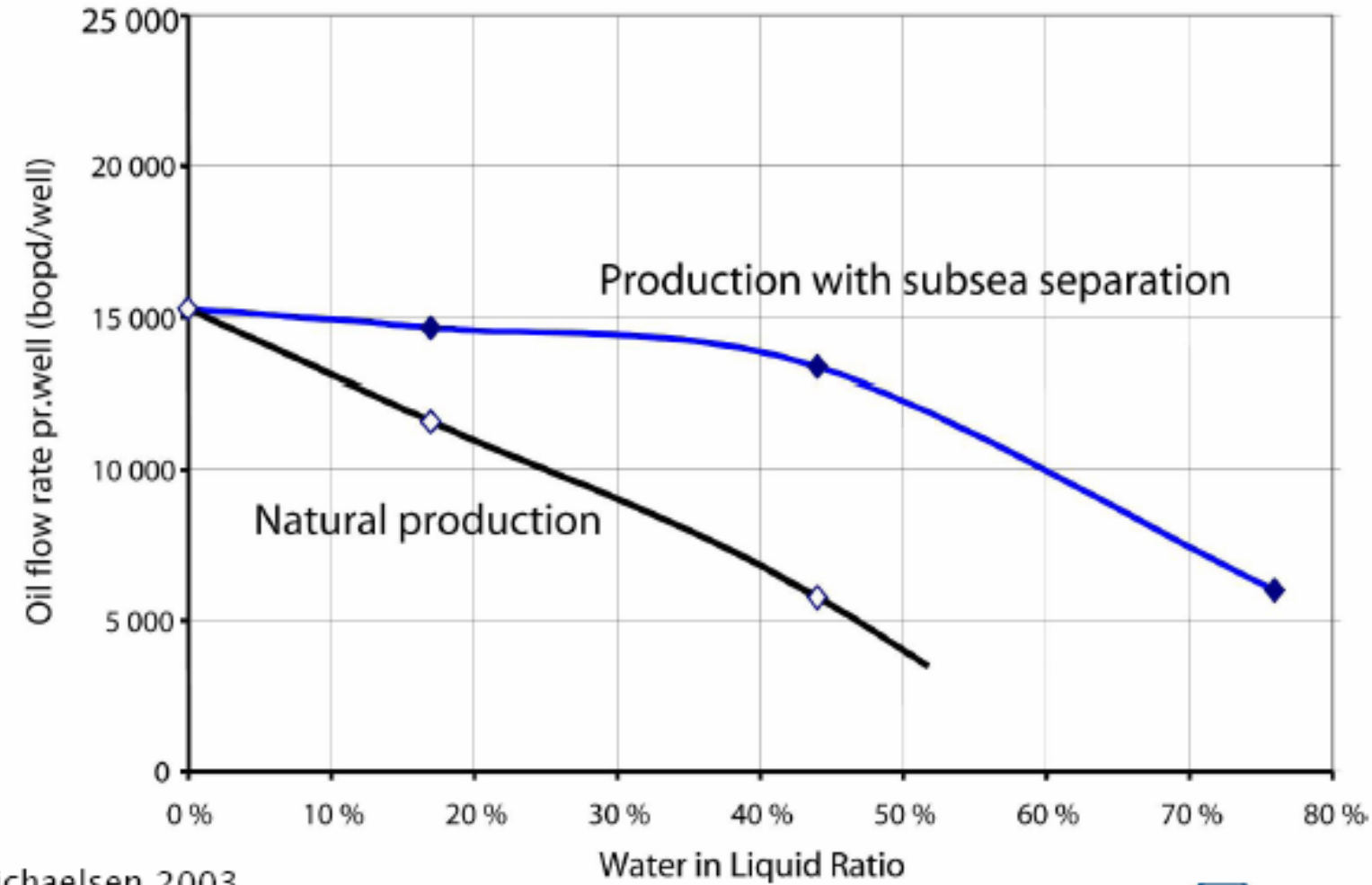


Type 2 Subsea Processing – Separation: Conceptual Design



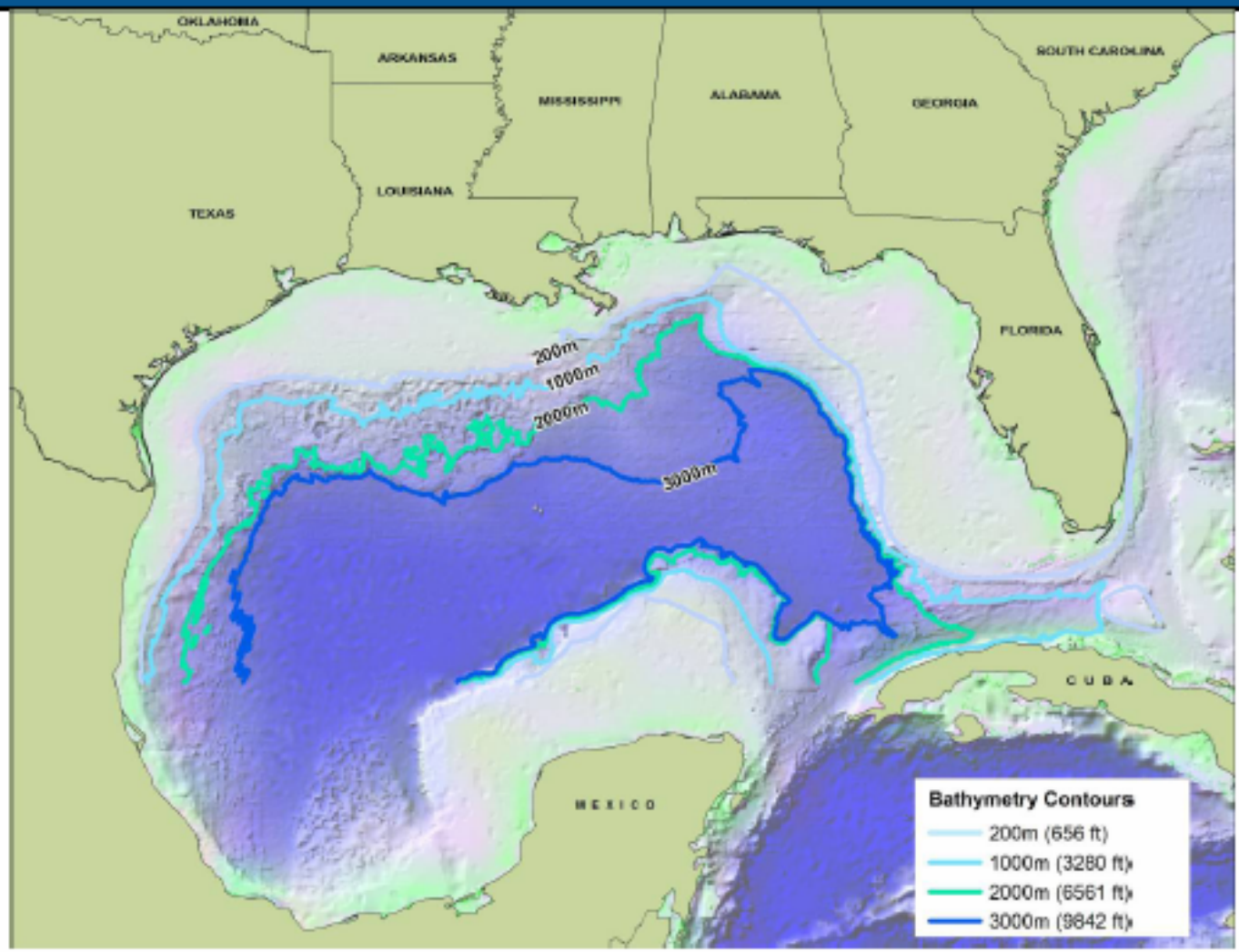
Gustafson et al. 2000

Comparison of Production with and without Subsea Separation

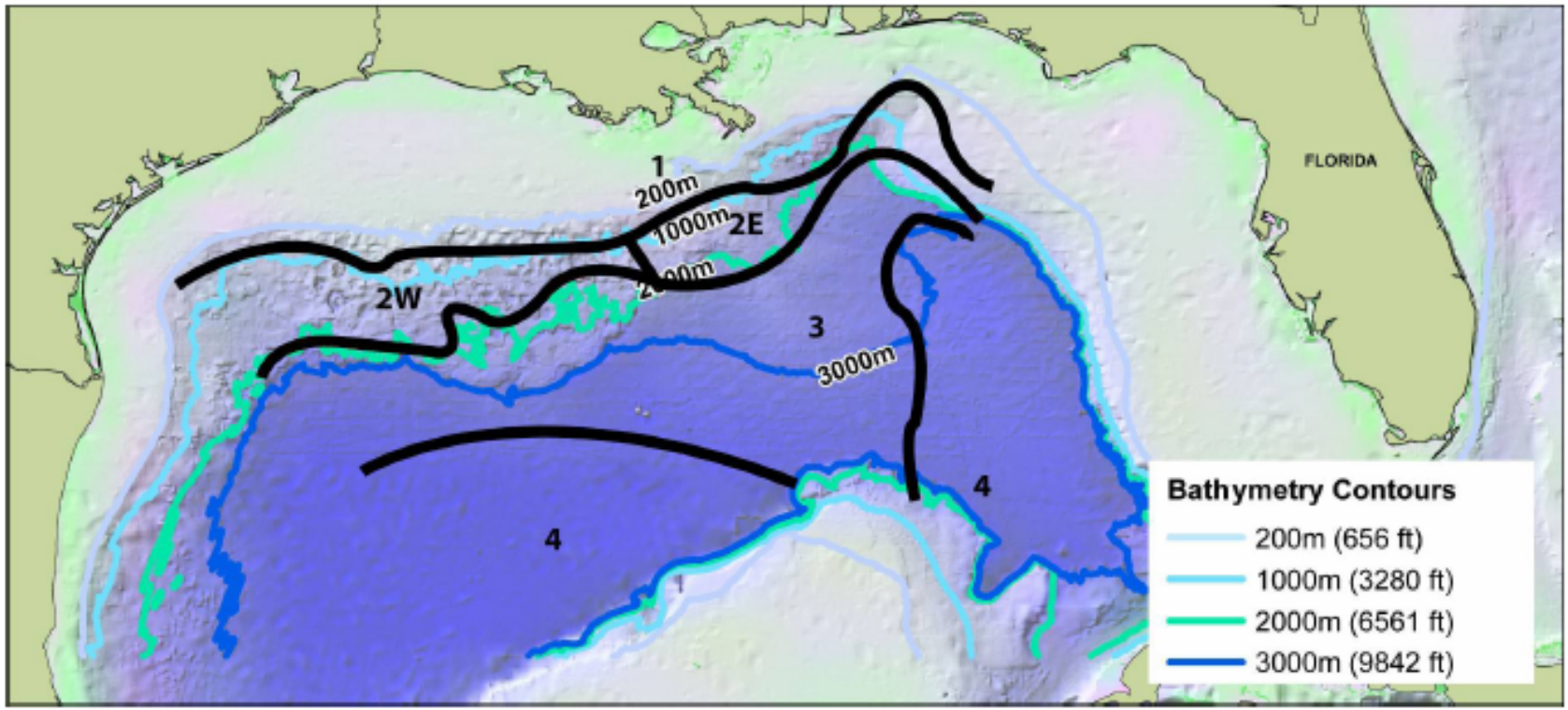


Michaelsen 2003

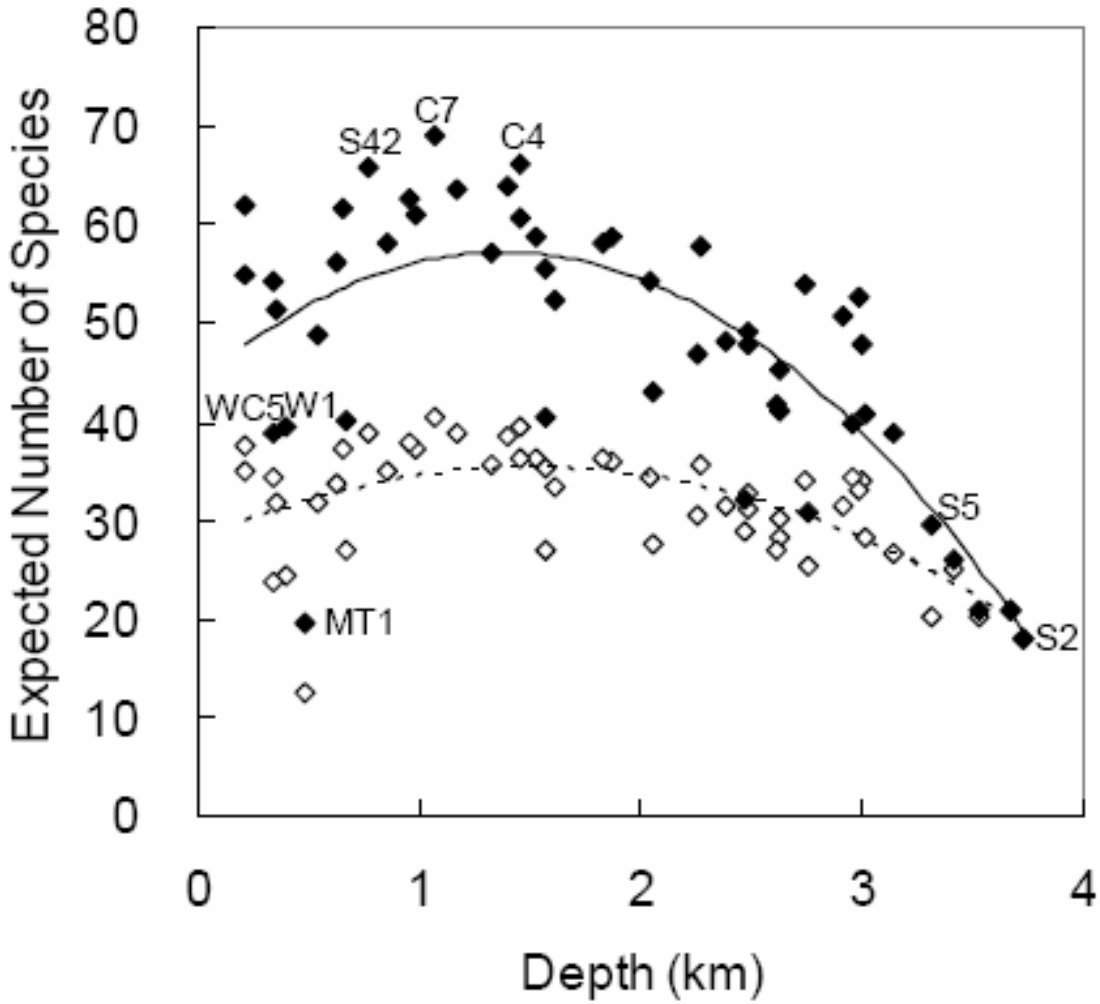
Task 2: Environmental and Biological Conditions in the Deep GOM



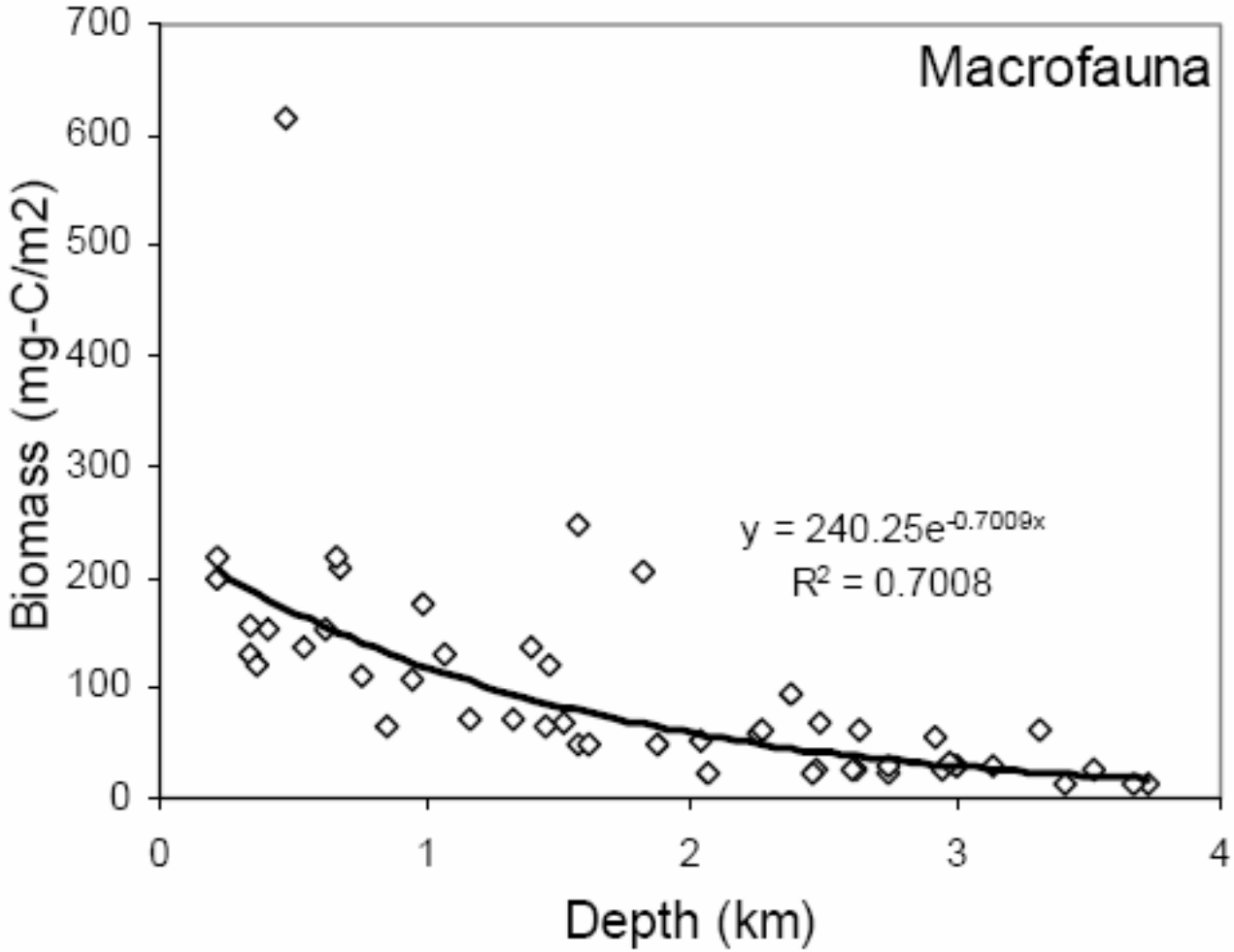
Macrofaunal Community Zonation



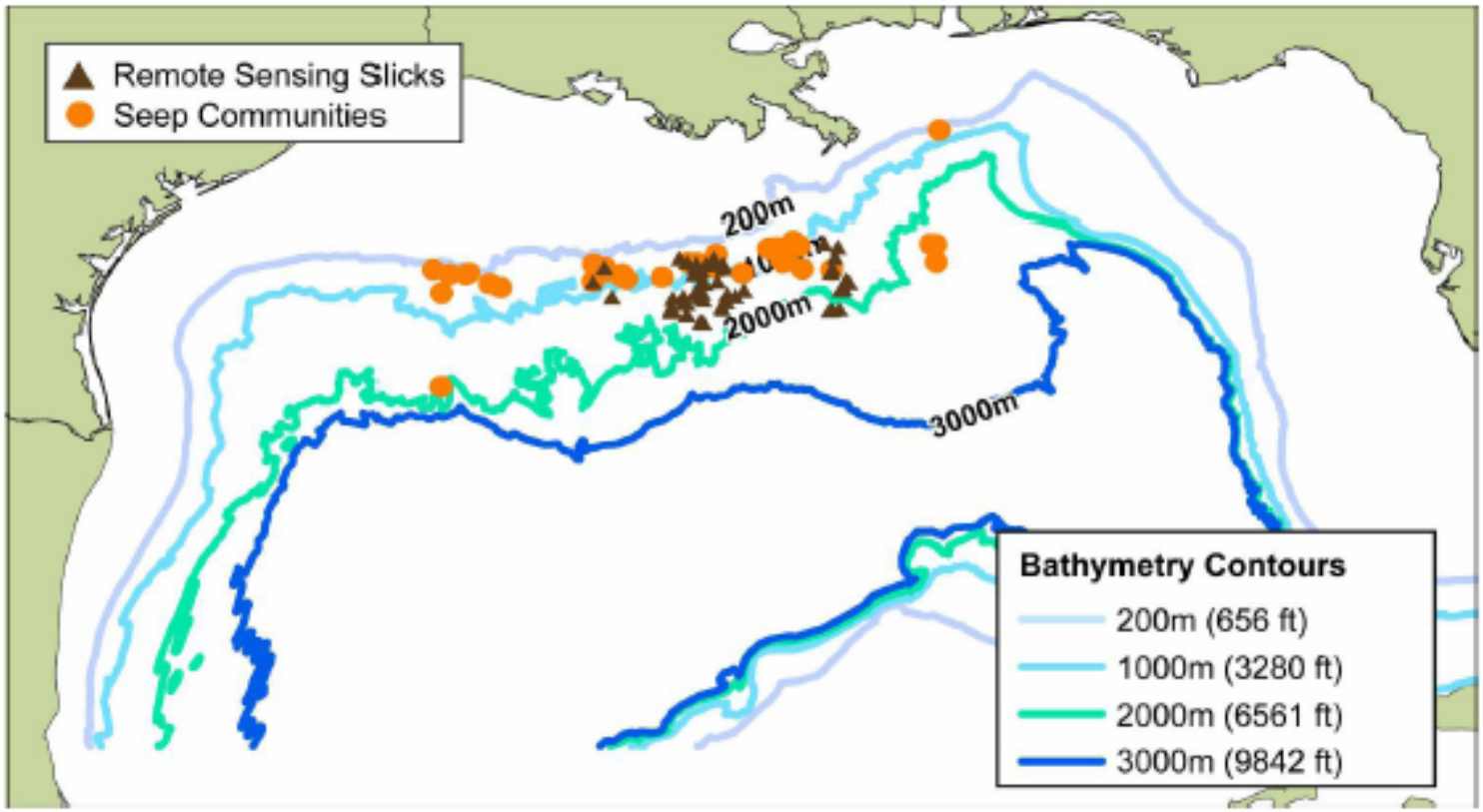
Macrofaunal Species Diversity



Effect of Depth on Macrofaunal Biomass

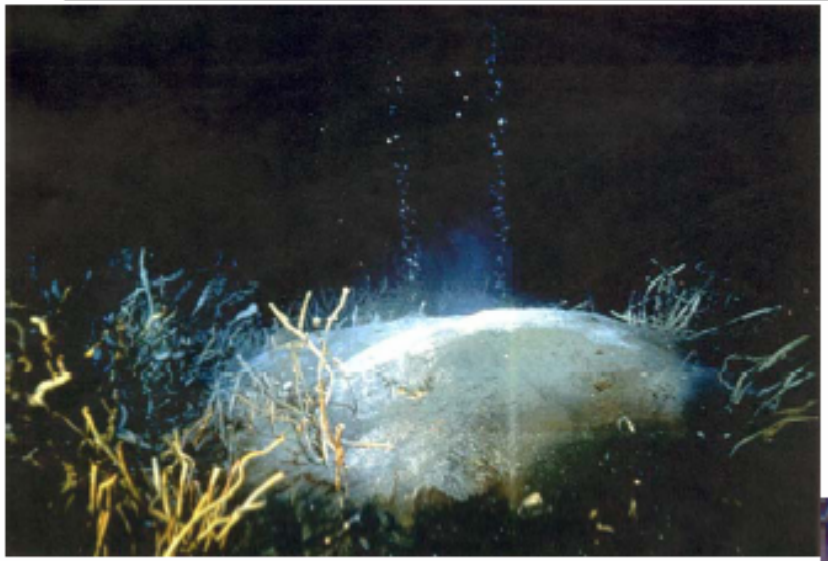


Location of Known Chemosynthetic Communities in the Gulf of Mexico



MacDonald 2002

Chemosynthetic Communities



MacDonald 2002

Potential Effects from Subsea Processing

Activity/consequence	Potential Effect	Effect on Regulations
Siting and construction/habitat disruption	Geohazards: mass wasting, loss of surface sediments, release of entrapped fluids	Existing regulations specify distance from sensitive communities
Drilling/release of muds and cuttings	Standard techniques; greater reliance on synthetic fluids; unknown biodegradation rates; unknown community level effects	Existing regulations for handling of muds and cuttings
Operations/chemical releases	Addition of hydrate and scale inhibitors, wax formation	Methanol and glycol have low toxicity
Operations/produced water & sands	Treatment & release at surface, toxicity	Existing regulations require surface treatment
Operations/leaks & small spills	Moderate to high probability, uncontained releases, detection and intervention difficult Relief systems/safety valves	Existing regulations may need to be updated

Potential Effects from Subsea Processing (2)

Activity/consequence	Potential Effect	Effect on Regulations
Operations/large spills & blowouts	Fewer wells relative to shallow water; fewer workover operations; DeepSpill and modeling demonstrated ability to predict behavior of O&G release; Intervention difficult	Existing regulations
Operations/thermal effects	65% efficiency, high temperatures (60°C), effects on hydrate communities, metabolic effects, thermal mixing	Temperature effects not addressed under existing regulations
Operations/noise	Interference with biogenic sounds	Noise effects not addressed under existing regulations
Operations/interference with fisheries	Fish attracting devices, reef effects; Electromagnetic effects on fish/benthos	Existing regulations do not address reef effects; Electromagnetic effects unknown

Primary Environmental Issues on Biological Communities

❑ Effects on benthic communities

- Community not well characterized
- Factors affecting zonation not well understood
- Difficult to detect effects (low abundance, biomass and diversity)
- Chemosynthetic communities
  - Rare and fragile
  - Ubiquitous and robust
- Absence of ecosystem perspective (knowledge of consequences)
- Monitoring
  - Increased costs
  - Difficult to sample
  - Need for new metrics

Primary Environmental Issues Associated with Operations

- Ability to monitor releases (petroleum, produced water & sands)
- Leak/loss detection
- Effects of deepwater blowouts
- Intervention

References

Gustafson, S., W. Bakke, and J. Michaelsen. 2000. Subsea separation: The way into the new millennium. Journal of Petroleum Technology 52(8):50–51.

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