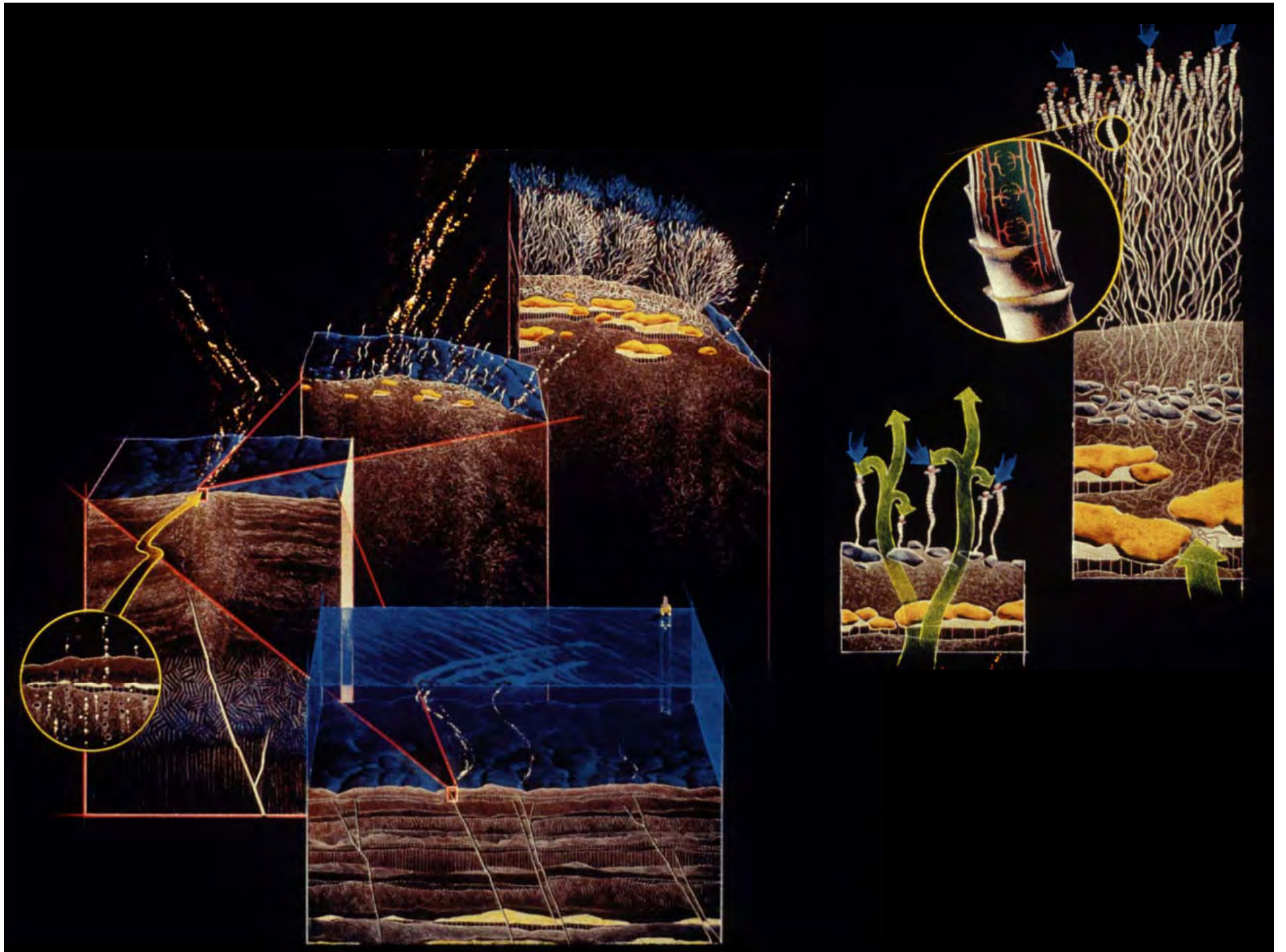




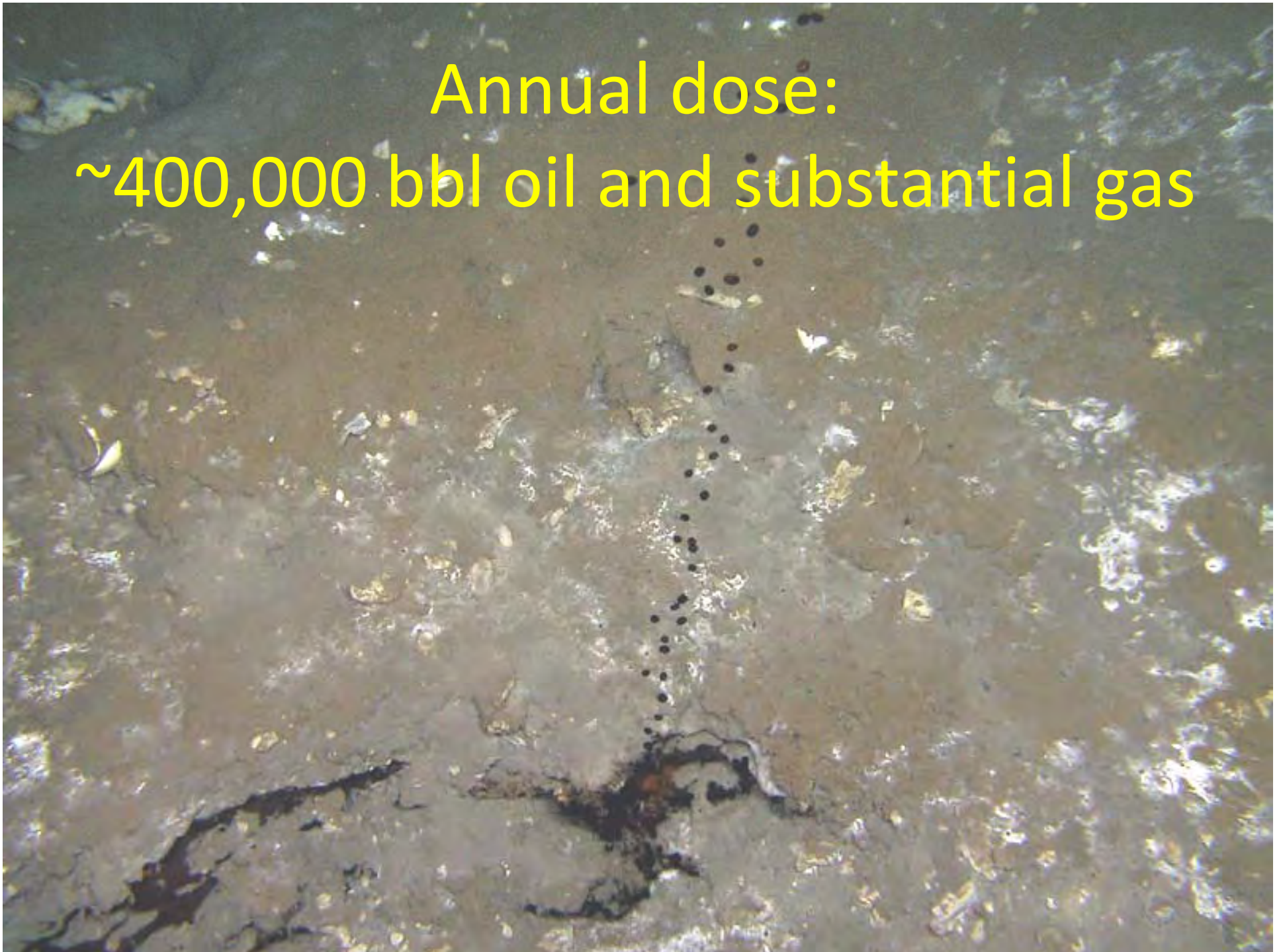
Deep Gulf Communities: Natural and Unnatural Oil Exposures

Ian MacDonald,
Florida State University



Annual dose:

~400,000 bbl oil and substantial gas



CAGE
THR: 0
DPT: 4850'
HDG: 089
TRN: 0.5

Maxx 3

30 45 60 75 90 105 12

P: -4 074 R: 1
TRN: -0.5

ROV
DPT: 4922'
ALT: 87
BTY: 5009'

Daily dose:
~60,000 bbl oil,
~30,000 BOE gas

OCEANEERING

CAGE
THR: 0
DPT: 4840'
HDG: 090
TRN: 0.5

Maxx 3

60 75 90 105 120 135

P: -4 095 R: -1
TRN: -0.5

Dive Number: 37

06/03/10
14:32:06

ROV
DPT: 4936'
ALT: 70
BTY: 5006'

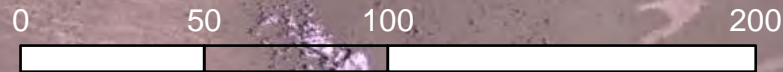
OCEANEERING

Dive Number: 37

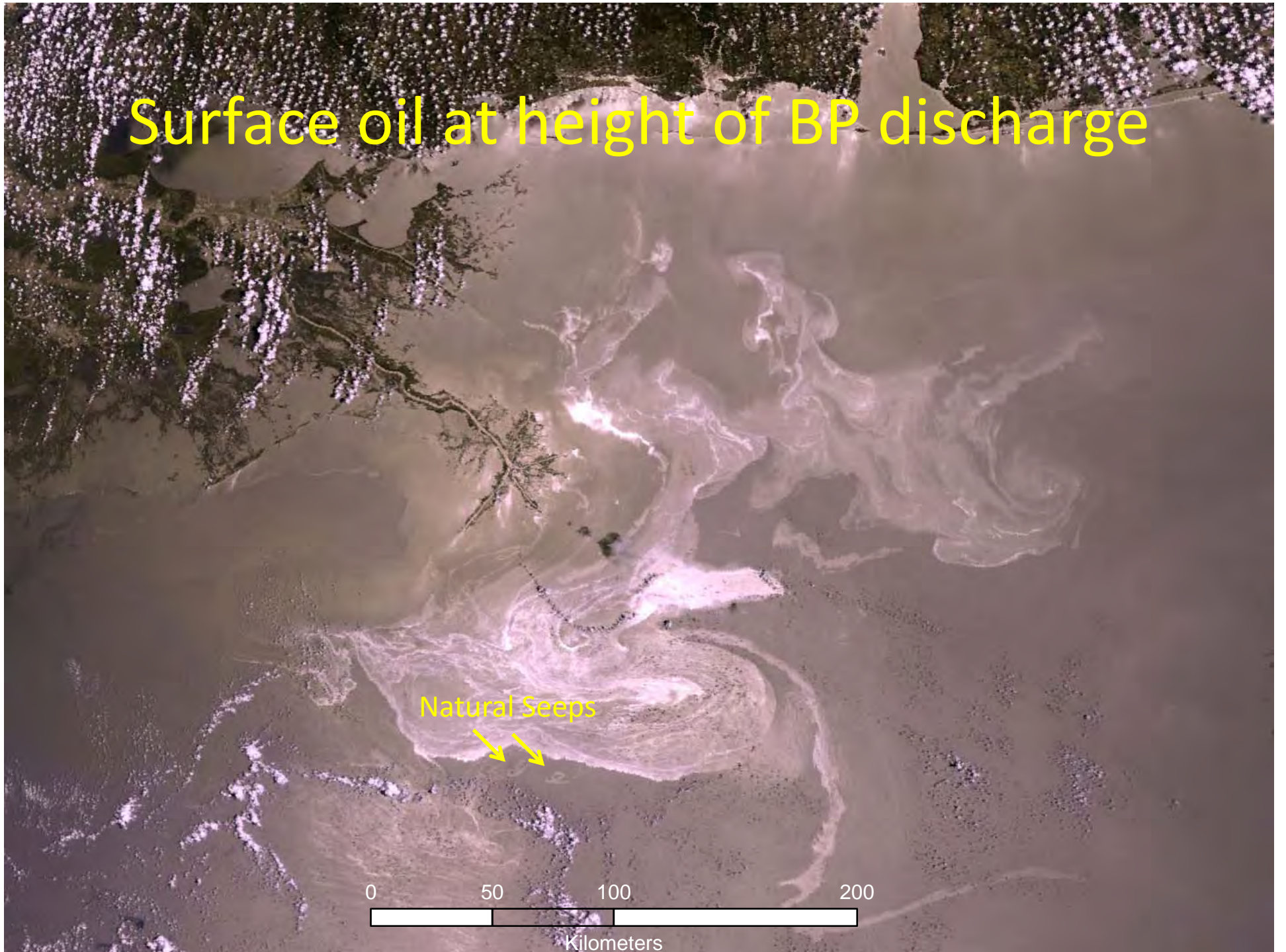
06/03/10
14:31:29

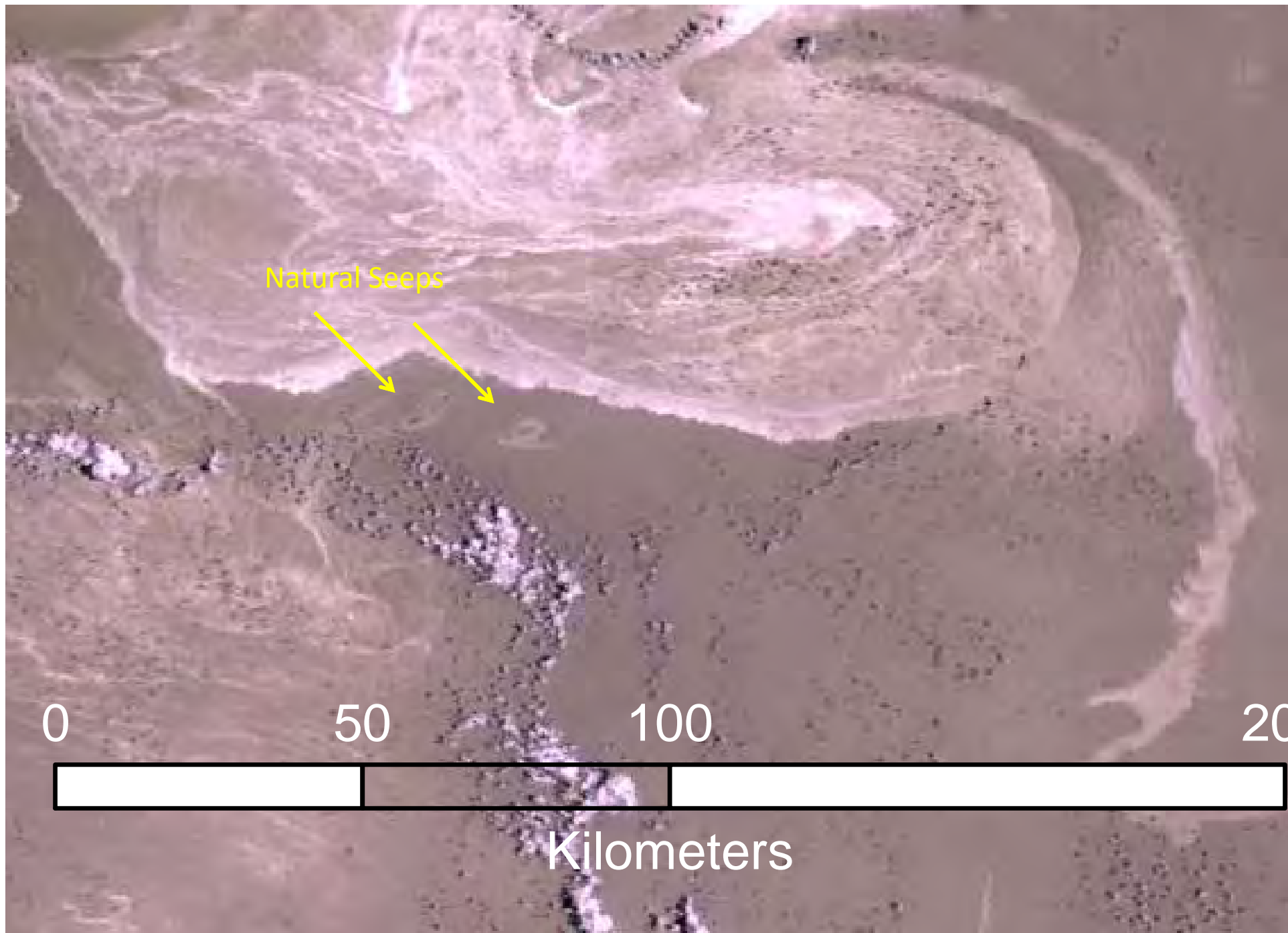
Surface oil at height of BP discharge

Natural Seeps

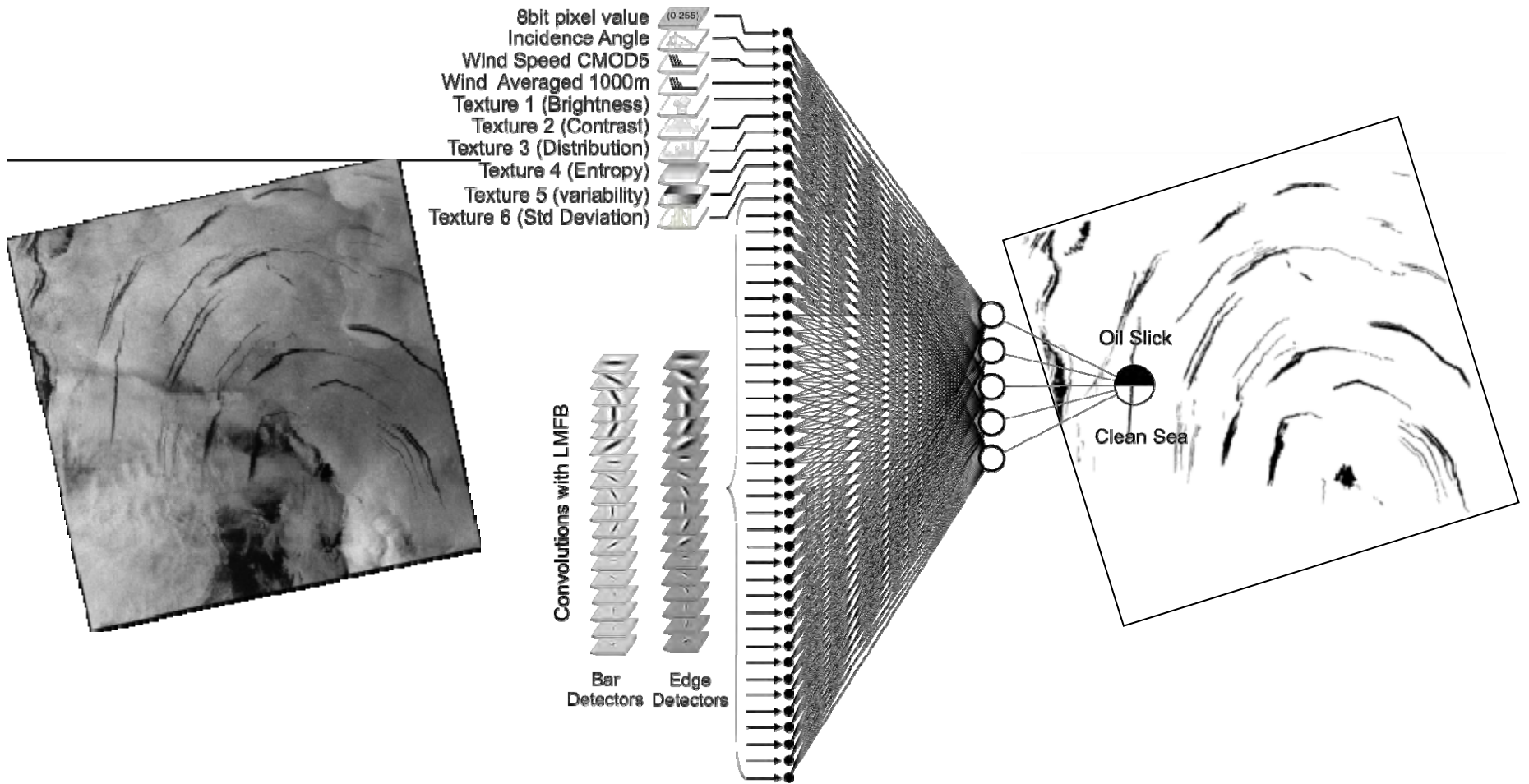


Kilometers





Texture Classifying Neural Network Algorithm

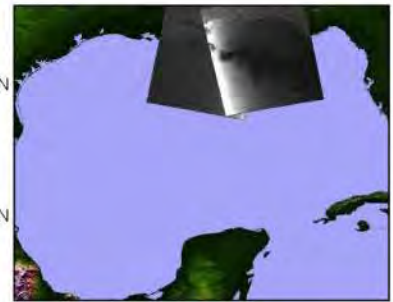
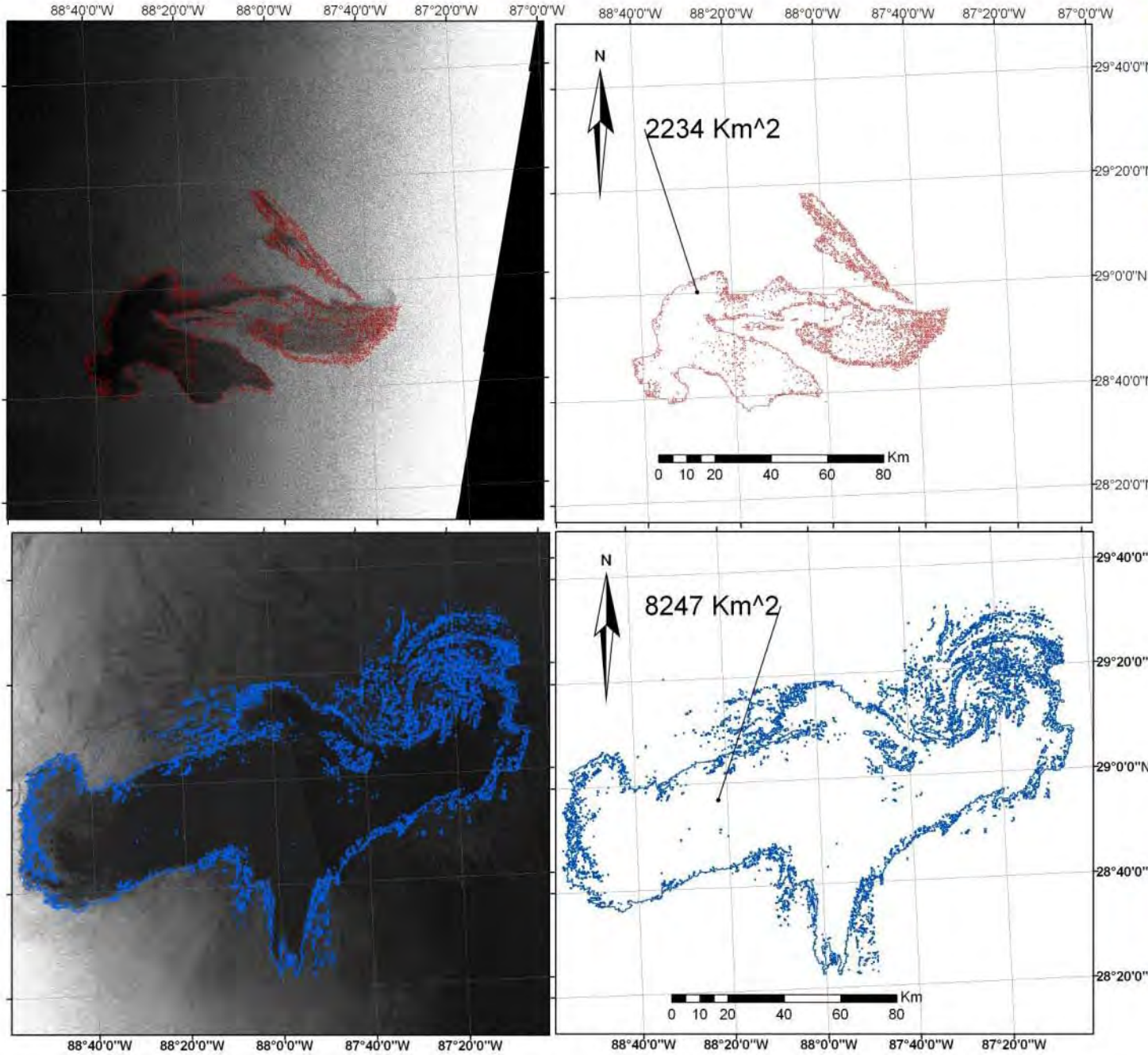


File size ~100 Mbyte

File size ~1 Mbyte

Remote Sensing Inventory

TCNNA Analysis on ENVISAT SAR (04/26/2010 & 04/29/2010)



Symbology

- Oil Spill 4/26/2009
- Oil Spill 4/29/2009

TCNNA Analysis

On April 26 2010, at 15:58 hrs, Using TCNNA on a ENVISAT SAR Image ASAR WSM Mode 2234 Km² were classified as sea surface waters containing Oil.

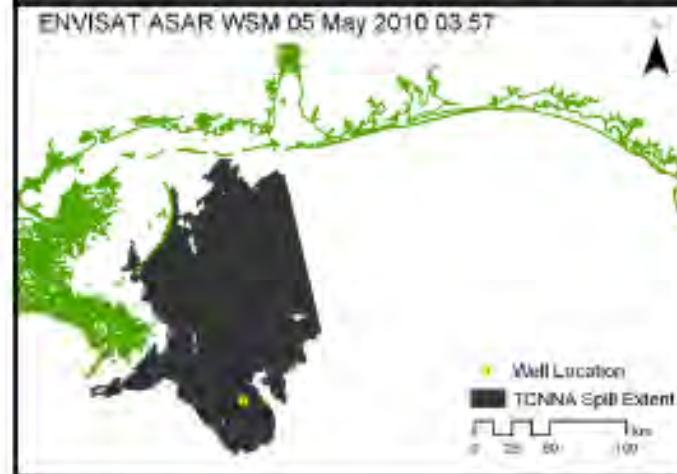
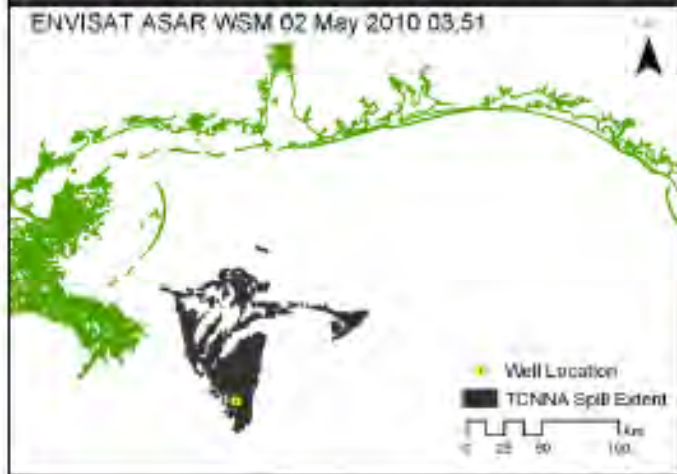
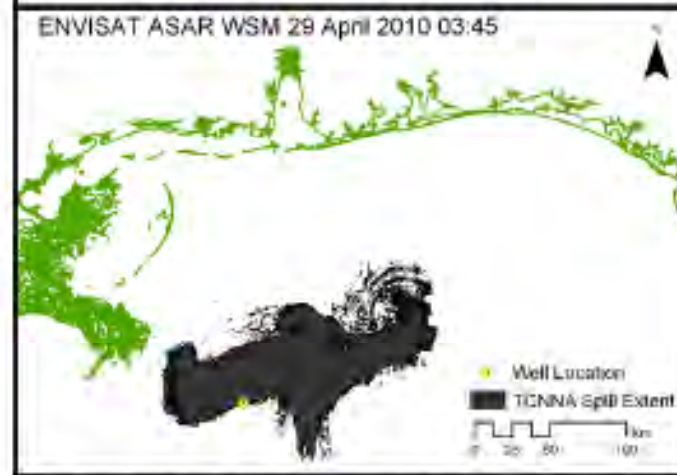
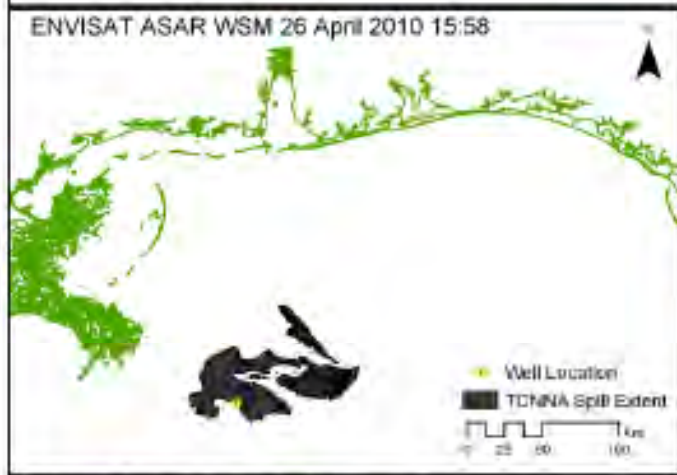
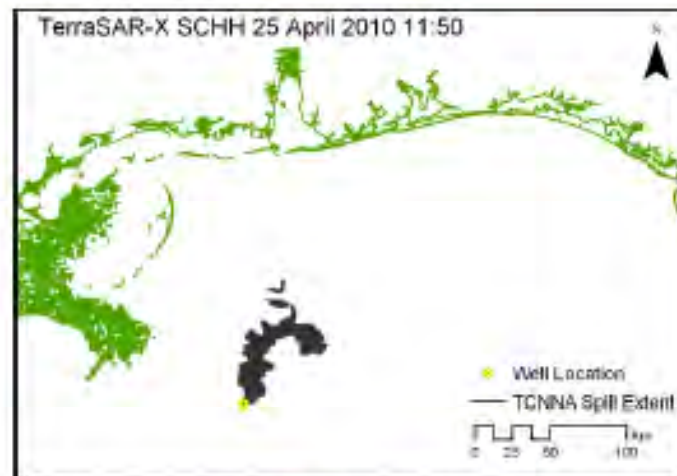
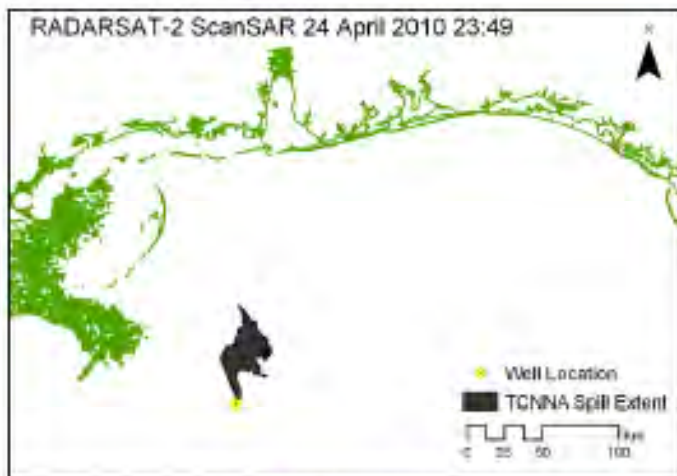
On April 29 2010, at 03:45 hrs, Using TCNNA on an ENVISAT SAR Image ASAR WSM Mode 8247 Km² were classified as sea surface waters containing Oil.



NOAA/NESDIS
Xiaofeng Li
William Pichel
Christopher Jackson



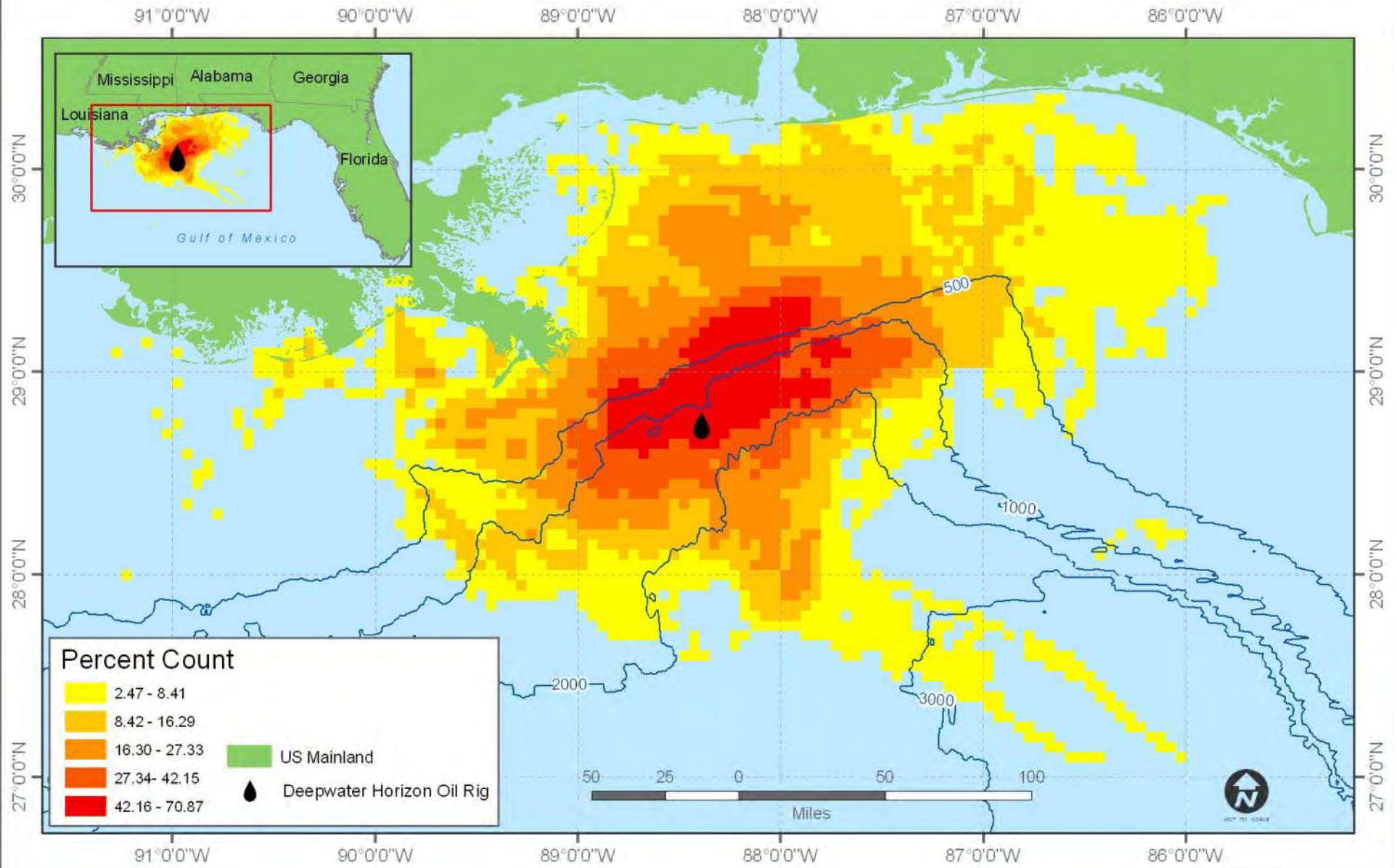
EOAS Department
MacDonald Image Lab
Oscar Garcia-Pineda
Ian MacDonald



BP's Oil Spill Analysis. Normalized Detection of Surface Oil.



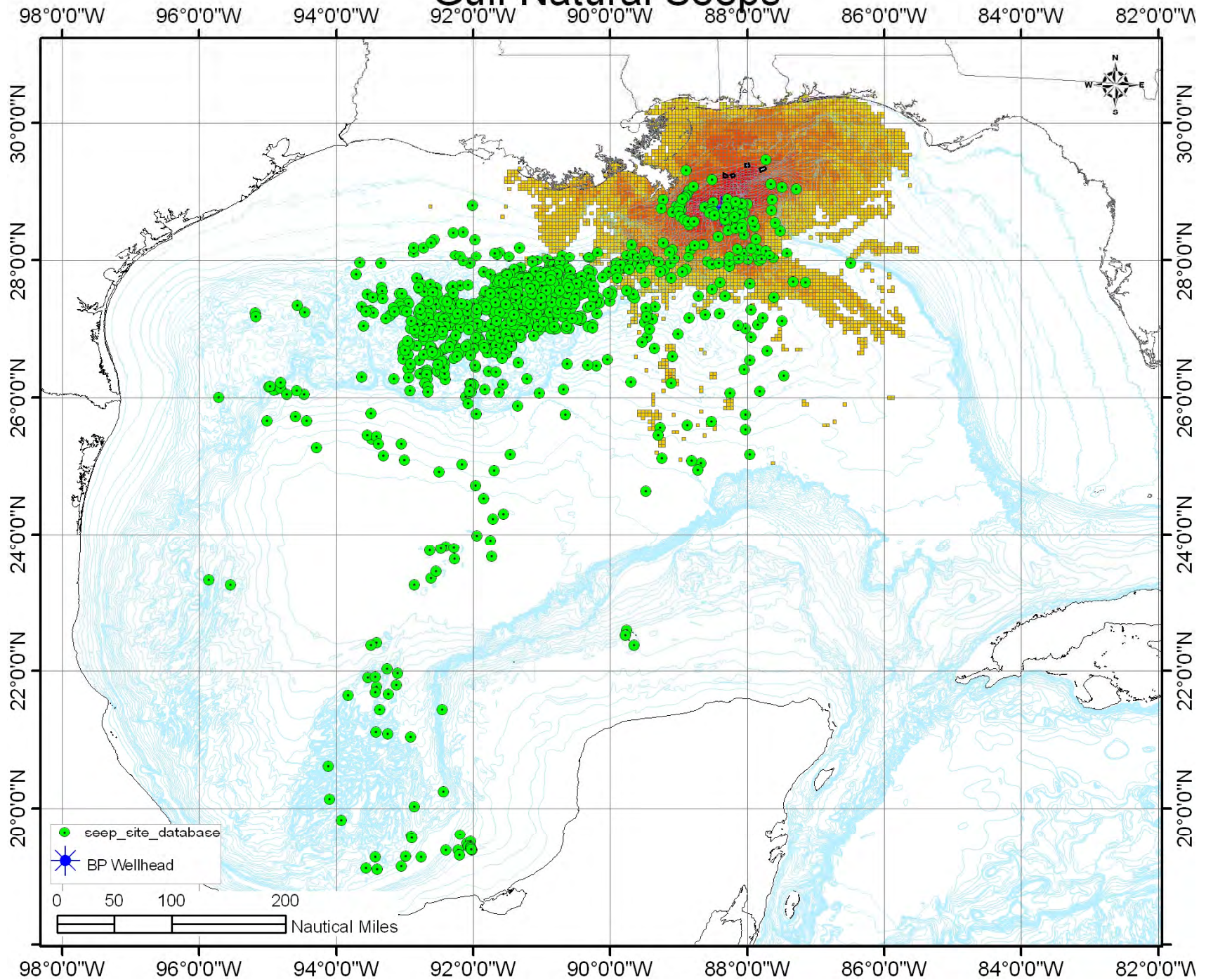
MacDonald Image Lab
Dr. Oscar Garcia-Pineda
EOAS Department



Projection WGS_1984
Date September 10, 2010

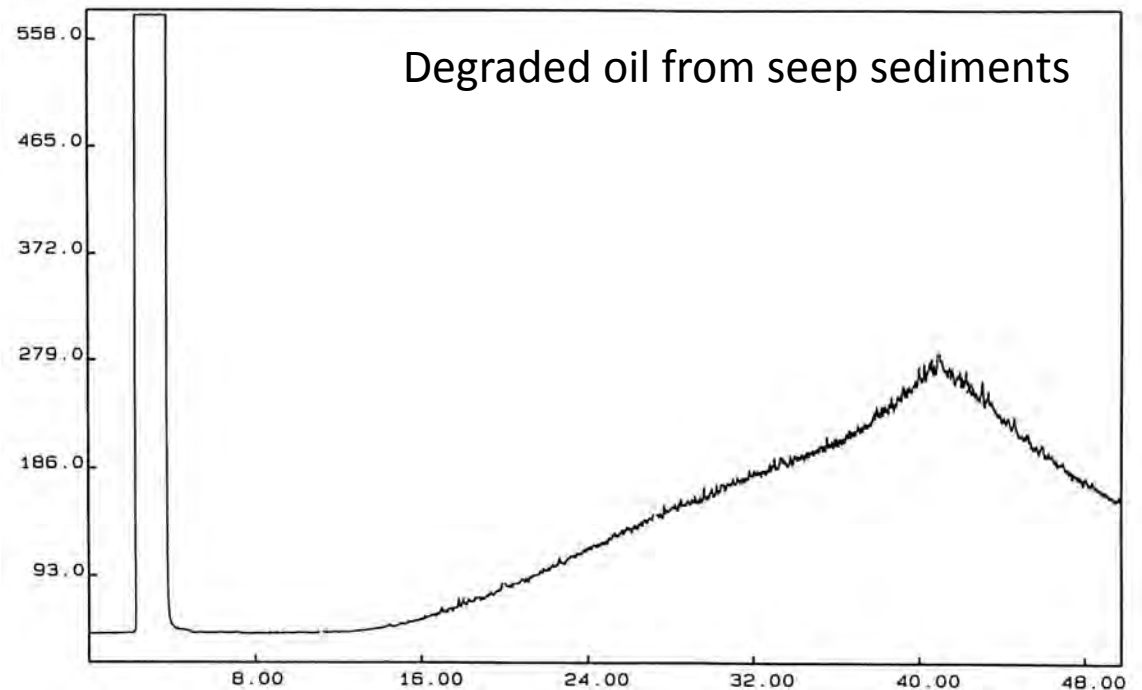
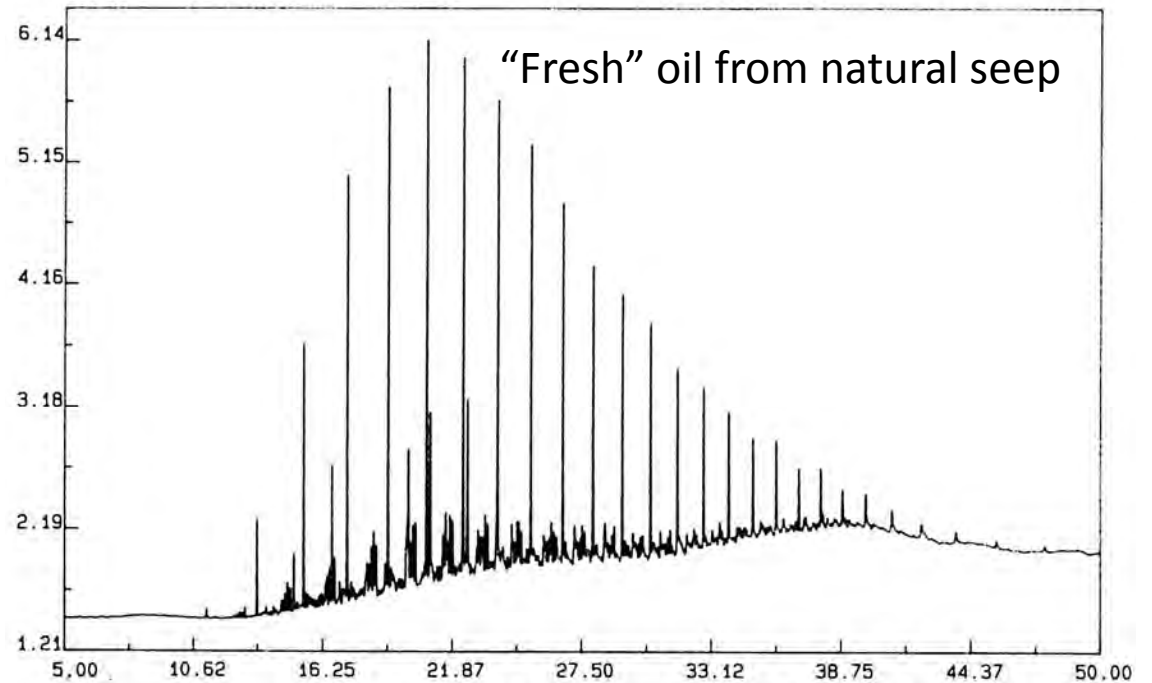
Source TCNNA
32 Envisat ASAR frames

Gulf Natural Seeps



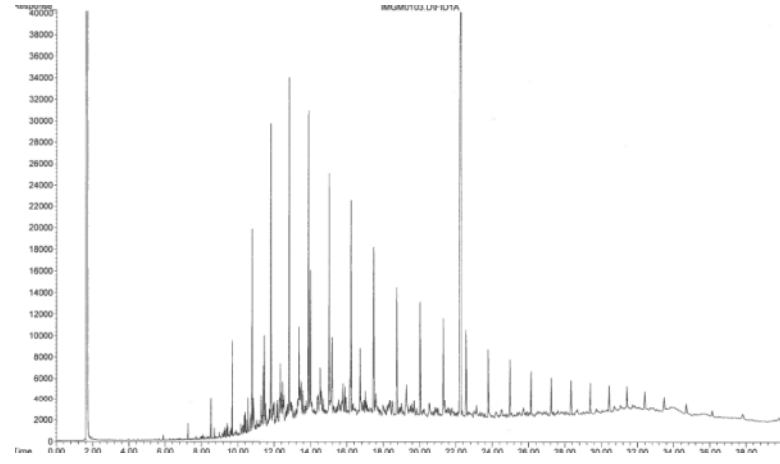
Fresh & Degraded Oil

- Crude oil is a mixture of many different molecules.
- Straight-chain alkanes are abundant in fresh oil.
- Microbes prefer alkanes and will consume them first in seep sediments.
- Eventually, biodegradation leaves a complex mixture of “other stuff” like asphaltenes. The alkanes disappear.

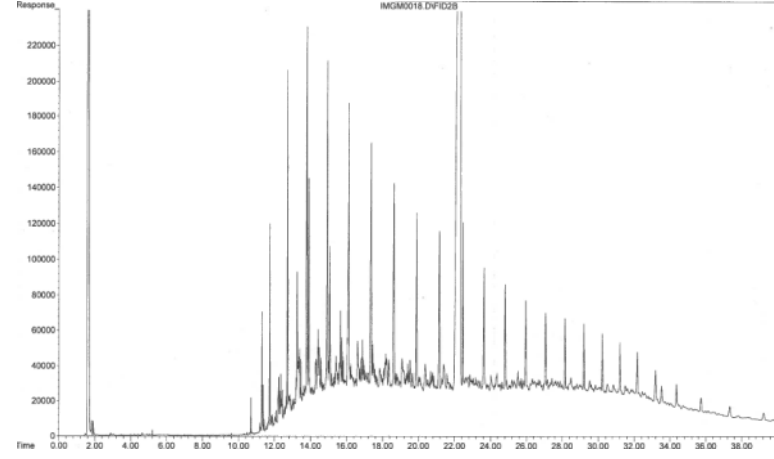




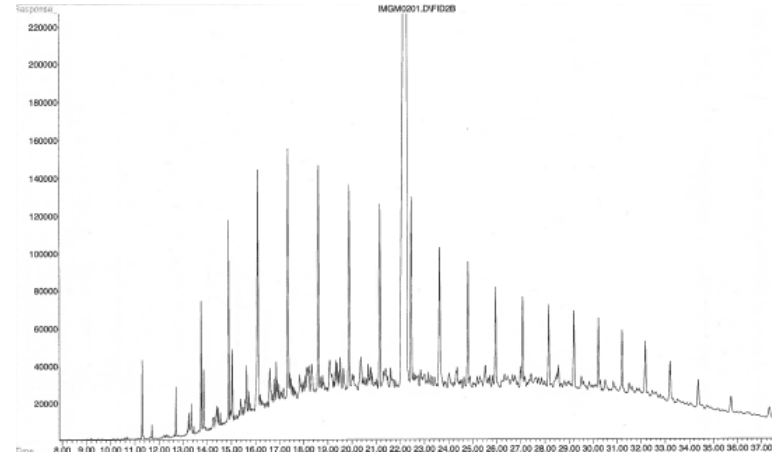
Freshly surfaced oil
12 July, ~3km from
wellhead



Weathered oil (> 1mm)
26 May, ~75 km from
Wellhead (NE Pass, LA)



Emulsified oil
23 July, ~95 km from
Wellhead (S Pass, LA)



Deep-sea Benthic Samples N-NE of well-site found oil layers and dead organisms

(courtesy S. Joye)

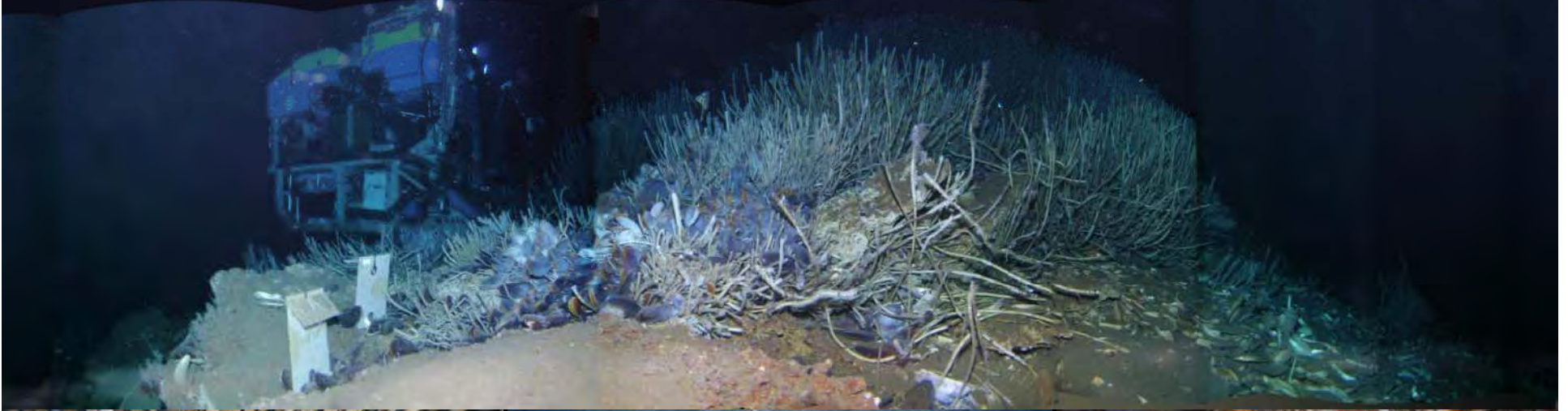


Shipek Grab samples from stations 1 and 2 miles off of Santa Rosa Island (South of Pensacola Pass). Two of three grabs contained sunken tar balls, asphaltic material. (Courtesy R. Synder)

**R/V Bellows 15-18 June 2010,
tar on shelf sediments south of Pensacola**



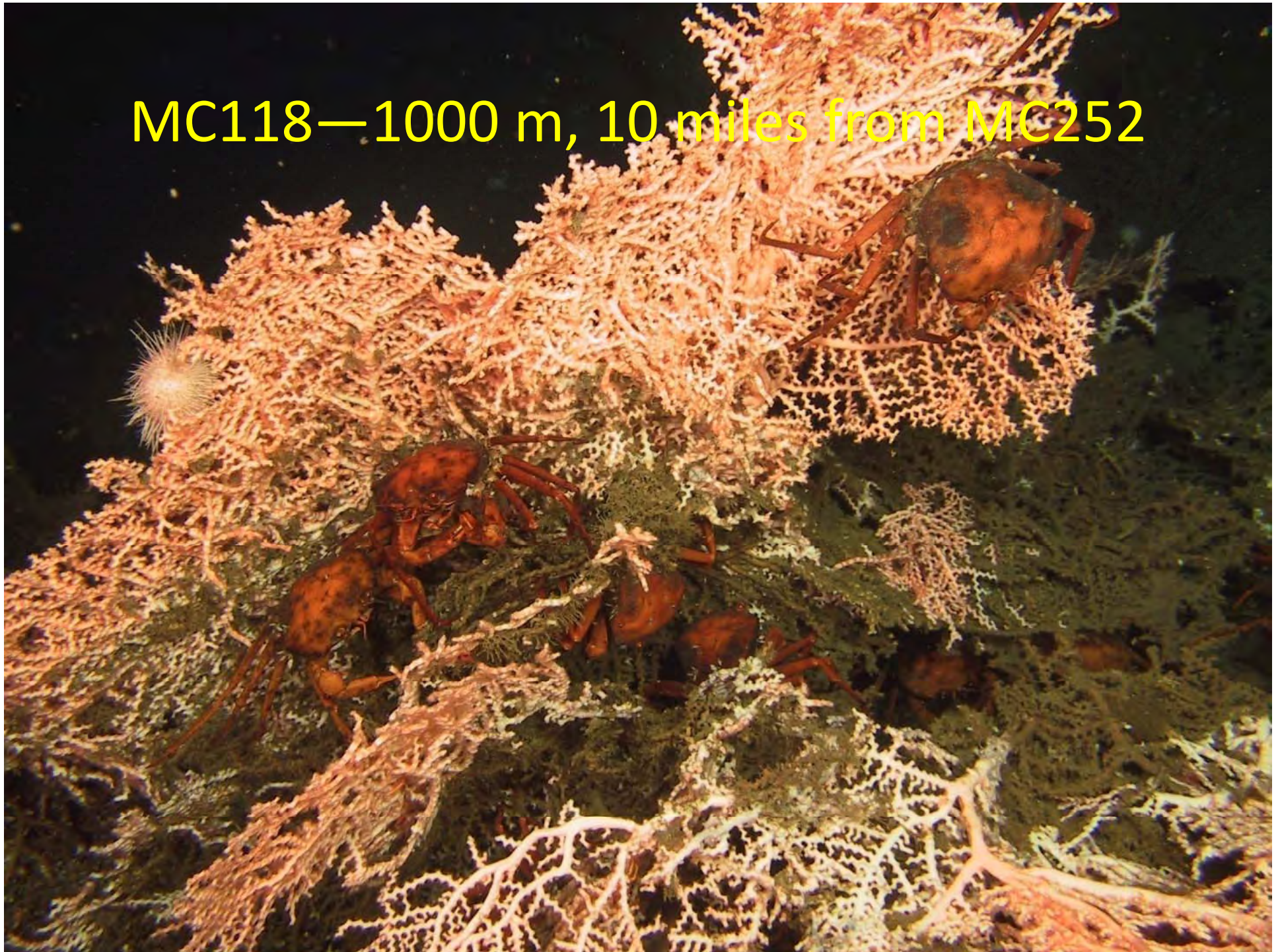
Natural Seep Fauna & Habitats



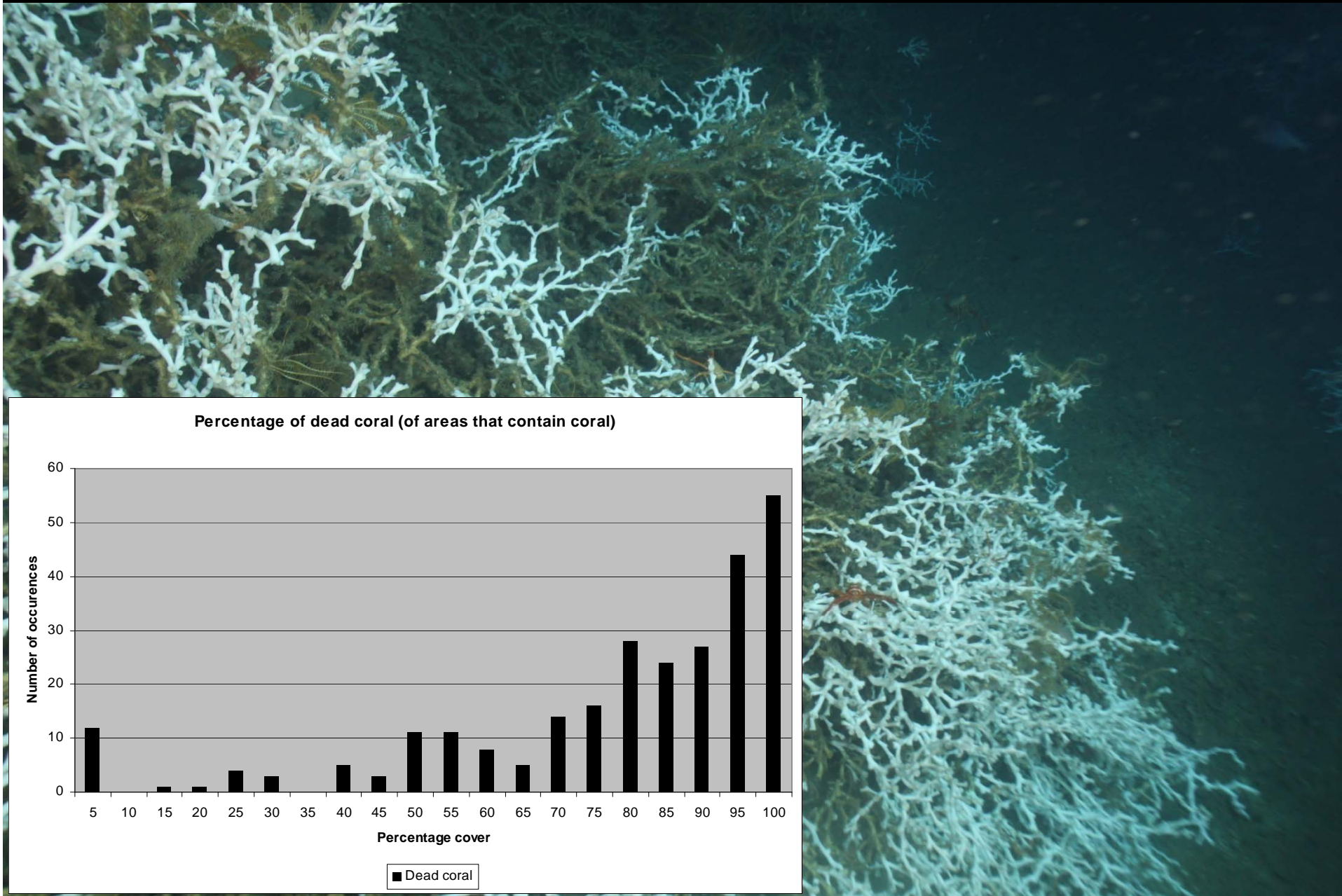
GC852—1500 m, 175 miles from MC252



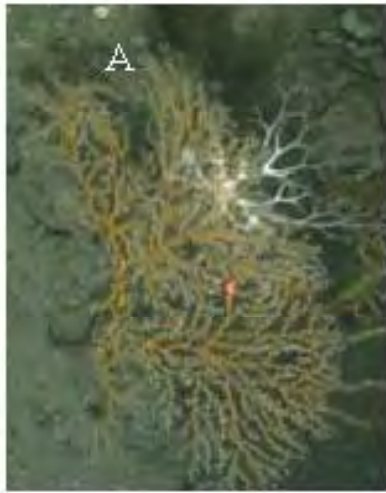
MC118—1000 m, 10 miles from MC252



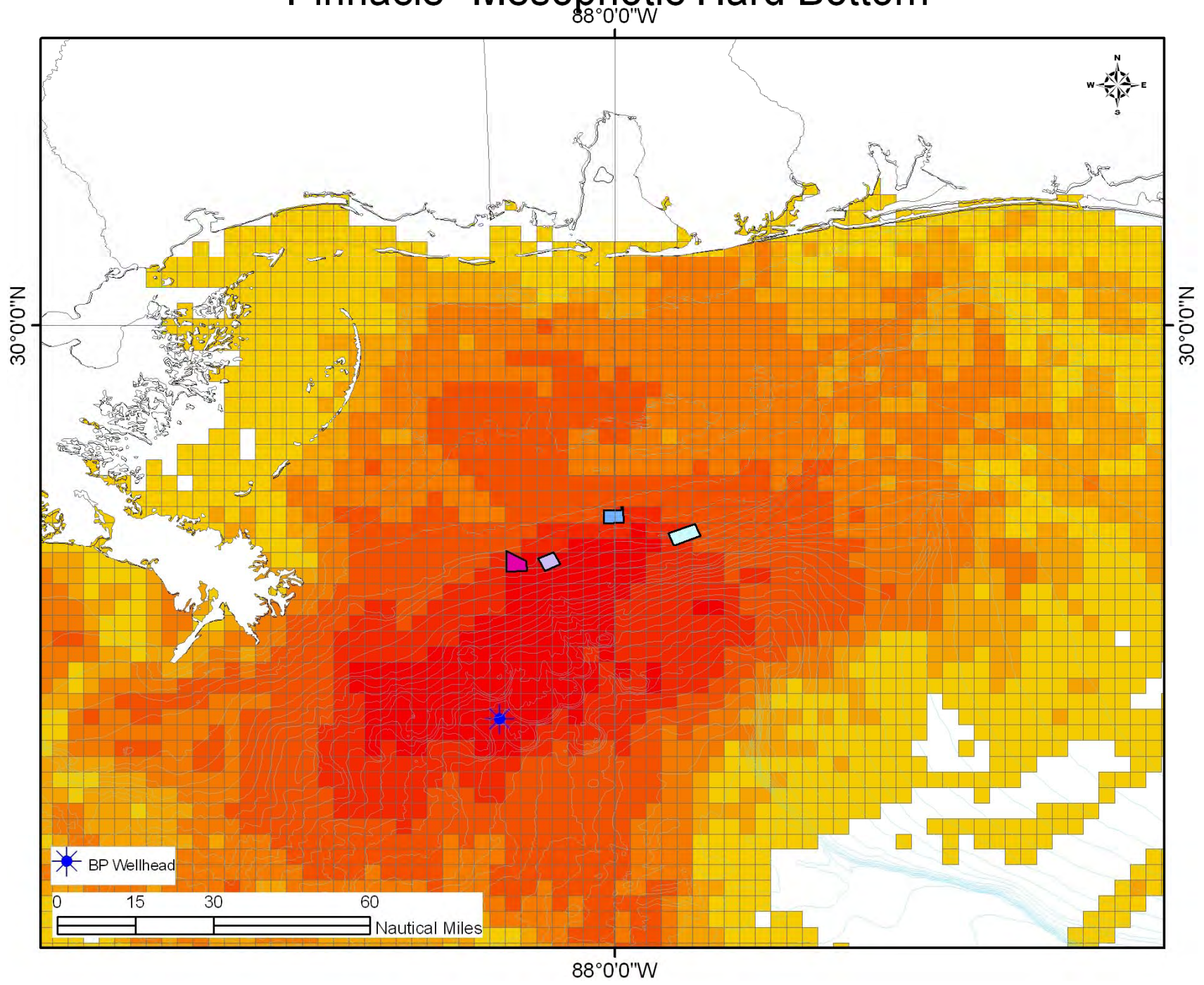
Lophelia—live & dead



Mississippi Alabama Pinnacles



Pinnacle--Mesophotic Hard Bottom



Megafauna

- Whales: Numerous toothed whale species including resident population of endangered sperm whales (~1650 pre-discharge)
- Turtles: All of the nine species occurring in the Gulf of Mexico are threatened or endangered.
- Sharks: Large individuals (tiger sharks, six-gilled shark) frequently caught at depth through DeSoto Canyon.

Whales and Dolphins of the Gulf of Mexico



Photo by Keith Mullin, courtesy of NMFS

Bottlenose Dolphin (*Tursiops truncatus*)

Size: Adults 6-12 feet. At birth approx. 3 feet.
Gulf of Mexico Population: 25,239* (shelf oceanic stocks)
Trivia: The original "Flipper" was a bottlenose dolphin named Mitzi and lived from 1956 to 1972.



Photo by Carol Roden, MMS

Spinner Dolphin (*Stenella longirostris*)

Size: Adults 6-7.2 feet; males slightly larger than females. At birth approx. 2.7 feet.
Gulf of Mexico Population: 1,989*
Trivia: Spinner dolphins get their name because they spin horizontally, from the tips of their beaks to their tails, over the water.



Photo by Carol Roden, MMS

Killer Whale (*Orcinus orca*)

Size: Adult males to 31 feet. Adult females to 23 feet. At birth approx. 8 feet.
Gulf of Mexico Population: 49*
Trivia: Killer whales are the largest species of dolphins.



Photo by Wayne Hoggard, courtesy of NMFS

Bryde's Whale (*Balaenoptera edeni*)

Size: Adults 43-51 feet; females slightly larger than males. At birth approx. 11 feet.
Gulf of Mexico Population: 15*
Trivia: Bryde's whales are the most commonly observed baleen whales in the Gulf of Mexico.



Photo by Craig Hayslip, MMS

Sperm Whale (*Physeter macrocephalus*)

Size: Adult males 49-59 feet. Adult females to 36 feet. At birth approx. 13 feet.
Gulf of Mexico Population: 1,665*
Trivia: "Moby Dick" was a sperm whale. Sperm whales are the only resident endangered cetaceans in the Gulf of Mexico.



Photo by Carol Roden, MMS

Atlantic Spotted Dolphin (*Stenella frontalis*)

Size: Adults 7-7.5 feet. At birth approx. 3 feet.
Gulf of Mexico Population: 27,393*
Trivia: The bodies of Atlantic spotted dolphins are covered with spots, and they become more densely spotted with age.



Photo by Keith Mullin, courtesy of NMFS

Risso's Dolphin (*Grampus griseus*)

Size: Adults 10-12.5 feet; males slightly larger than females. At birth approx. 5 feet.
Gulf of Mexico Population: 1,659*
Trivia: Risso's dolphins lose their gray pigmentation as they grow older and can appear almost white.



Photo courtesy of NMFS

Melon-headed Whale (*Peponocephala electra*)

Size: Adults 8.5-9 feet. At birth approx. 2.7 feet.
Gulf of Mexico Population: 2,283*
Trivia: Melon-headed whales have a preference for deep water. Their melon-shaped head gives them their name.



Photo by Carol Roden, MMS

Pantropical Spotted Dolphin (*Stenella attenuata*)

Size: Adults 5.2-8.5 feet. At birth approx. 2.7 feet.
Gulf of Mexico Population: 34,067*
Trivia: Pantropical spotted dolphins are the most abundant offshore marine mammals in the Gulf of Mexico.



Photo by Carrie Hubbard, courtesy of NMFS

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

Size: Adult males to 20 feet. Adult females to 17 feet. At birth approx. 5.5 feet.
Gulf of Mexico Population: 716*
Trivia: Short-finned pilot whales are highly communicative, making sounds such as squeals, whistles, smacks, and snores.



Photo by Carol Roden, MMS

Striped Dolphin (*Stenella coeruleoalba*)

Size: Adults 7-8 feet. At birth approx. 3 feet.
Gulf of Mexico Population: 3,223*
Trivia: Striped dolphins are beautifully marked, fast-swimming dolphins sometimes called "streakers."



Photo by Carol Roden, MMS

Clymene Dolphin (*Stenella clymene*)

Size: Adults 6-6.6 feet. At birth approx. 2.7 feet.
Gulf of Mexico Population: 6,575*
Trivia: Clymene dolphins are thought to feed nocturnally.

Size Comparison



There are at least 78 species of whales, dolphins, and porpoises throughout the world. Twenty-eight species of whales and dolphins are known to occur in the Gulf of Mexico, with about 20 species living in the Gulf year-round. Porpoises are not known to reside in the Gulf of Mexico. All of these animals are protected by the Marine Mammal Protection Act. The sperm whale is also protected by the Endangered Species Act.

Whales, dolphins, and porpoises share characteristics with humans. They have lungs and hold their breath while swimming underwater, so they must come to the surface to breathe. They also carry their young in the womb, give live birth, and nurse their young. These are some characteristics that classify them as mammals, in the taxonomic order of Cetacea.

The Minerals Management Service (MMS), a bureau of the U.S. Department of the Interior, is the Federal agency that manages the Nation's energy and mineral resources on the Outer Continental Shelf (OCS). The mission of MMS is to provide the American public with ocean energy, mineral resources, and the resulting economic value in a safe and environmentally sound manner. The MMS's support and funding of comprehensive studies of the possible effects of human activities on the distribution, abundance, and behavior of marine mammals are an important part of this mission.

* Gulf of Mexico populations from 2007 National Marine Fisheries Service stock assessments



MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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1-800-200-GULF
WWW.MMS.GOV

MMS 2008-001P

DATE: Mar 11 2006

TIME: 10:19:07

HEADING: 334

SPEED: 2855.89

Sperm Whale at 750 m



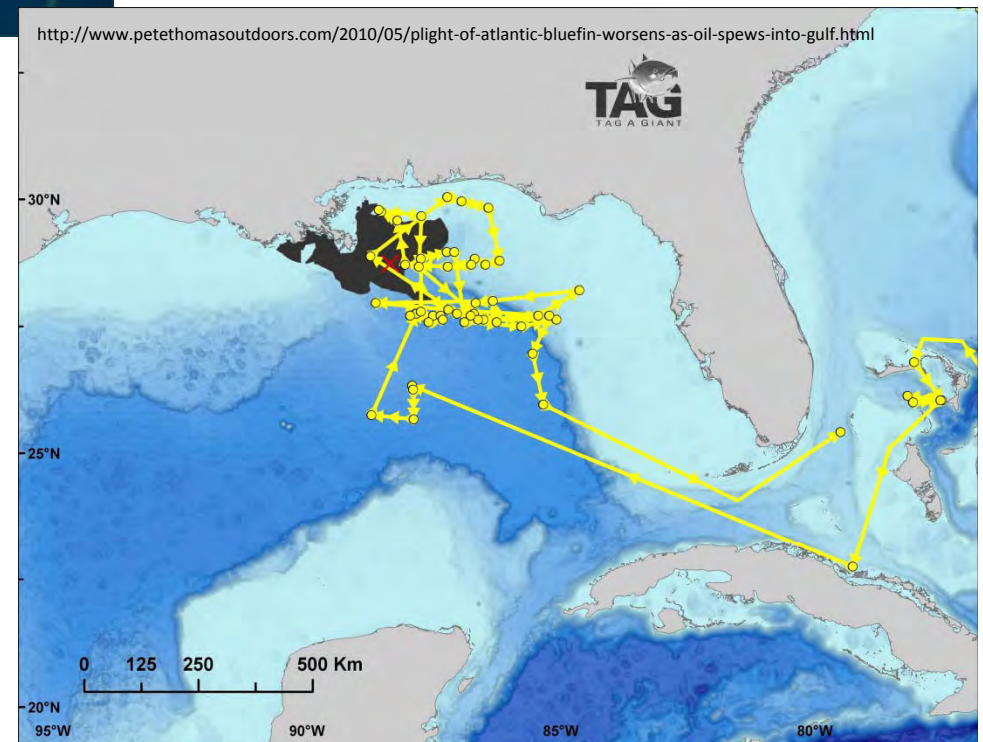
Canyon Offshore US-05

ALTITUDE: 7.870



Pelagic Spp.

Bluefin Tuna
Yellowfin Tuna
Blackfin Tuna
King Mackerel
Swordfish
Marlin & Sailfish



Dose: 0.8 teragram hydrocarbons

Experimental Outcome

- H_0 : There will be no lasting harmful effect of the oil discharge.

Gulf will quickly return to “normal” function

- H_A : Lasting, significant ecological impact

How will we know?

- My concern is for a fractional loss of productivity and biodiversity across a broad sector of ecosystem components (populations and habitats). The worst case scenario is tipping point effects from which populations may not recover.

Conclusion: I advocate two approaches

- Identify and monitor key habitats & populations to verify ecosystem health: E.g. pelagic—tuna, flying fish, whales; coastal—coquina, periwinkles, menhaden, etc.
- Put repayment of the Gulf of Mexico *ecosystem* in the front of the line. Use the BP fine (\$4B to \$24B) to establish an endowment to restore, understand, and sustain the coastal and marine environment in perpetuity.