

A historical map of the Gulf of Mexico region, showing Florida, Yucatan, and the Caribbean Sea. The map is overlaid with a semi-transparent dark box containing text. In the center of the map, there is a detailed illustration of a landscape with palm trees, a small building, and figures. The illustration includes a sign that reads 'TAMAICA' and 'PANUO'.

**Perspective on Fate and Effects.
Study Needs in the Southern Gulf of Mexico**

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Terms of Reference

Studies on the environmental effects of the energy sector

- Oil and gas
- Nuclear power

Offshore ecosystems

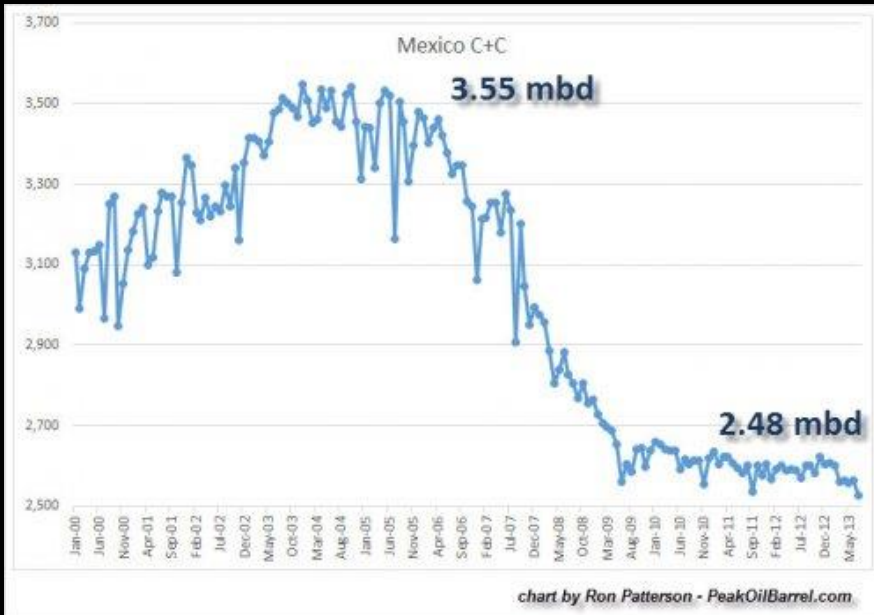
Southern Gulf of Mexico

Identify gaps

- Collaboration

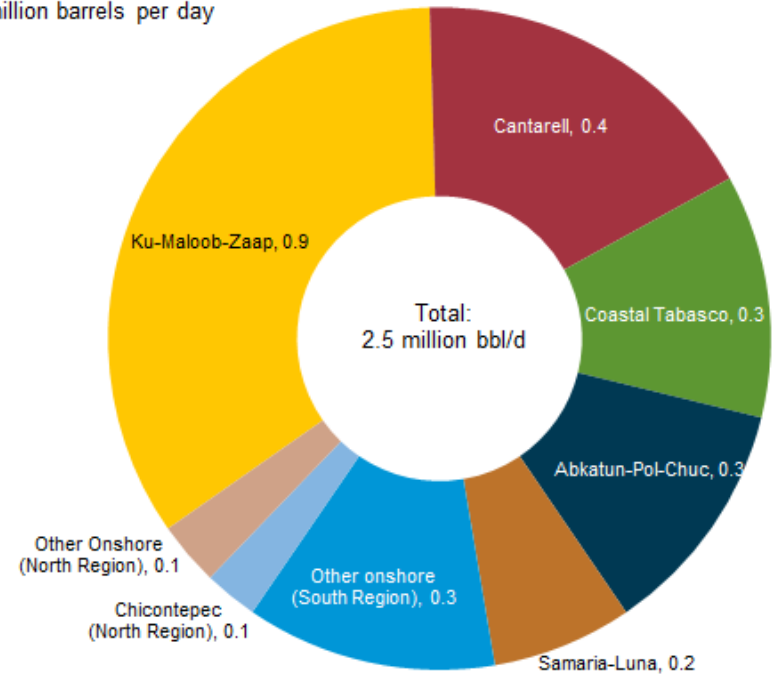
Oil Production in Mexico

Rapid decline from 2004



➤ Plus falling price

Mexico's crude oil production by field, 2013
million barrels per day



Source: PEMEX, Comision Nacional de Hidrocarburos

Most oil is produced offshore

Laguna Verde - Nuclear power plant



- ☛ Only nuclear plant in Mexico
 - Commissioned in 1990
 - Owned by CFE

- ☛ Same technology as the Three Mile Island power plant in the USA

- ☛ 20% expansion completed, pending licensing

- ☛ Produces 4.5% of Mexico's electric power
 - Two units, each 680 MW

- ☛ Only one environmental assessment found
 - May be suspect

Oceanographic Cruises



Industry Environmental
Assessment

PEMEX

- Long time series: 20 years or more
- Proprietary data
- Mostly Cinvestav and UNAM



Scientific oceanographic cruises

Mexican response to the Macondo oil spill.



Three series of three cruises: Years 2010, 2011, and 2012

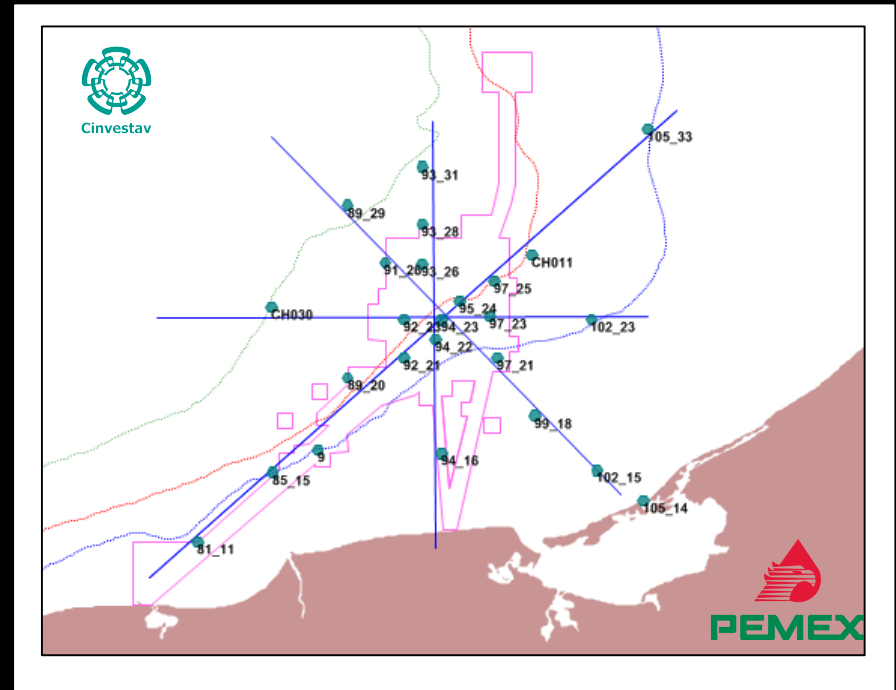
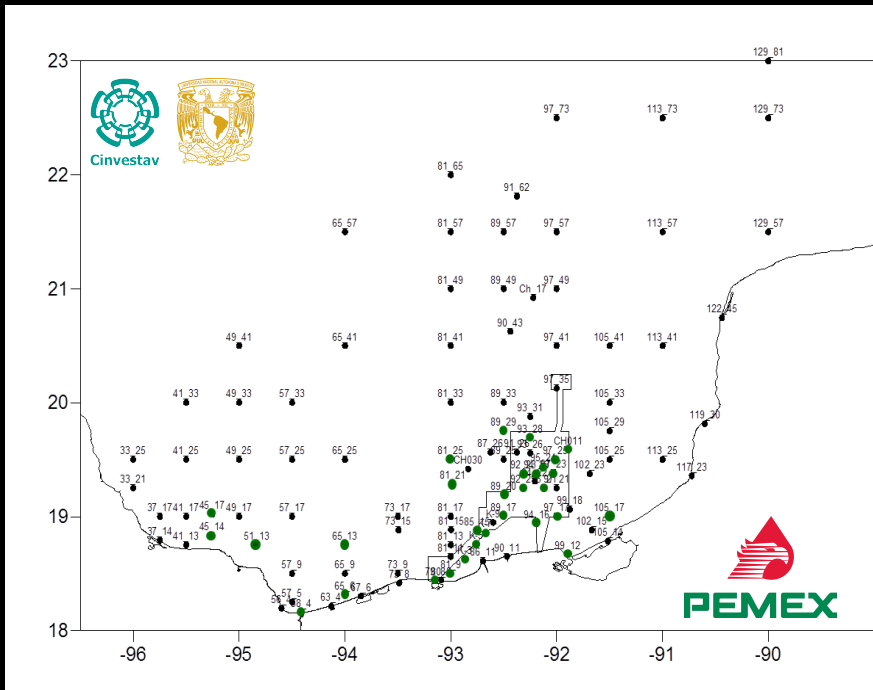


Ongoing mega project

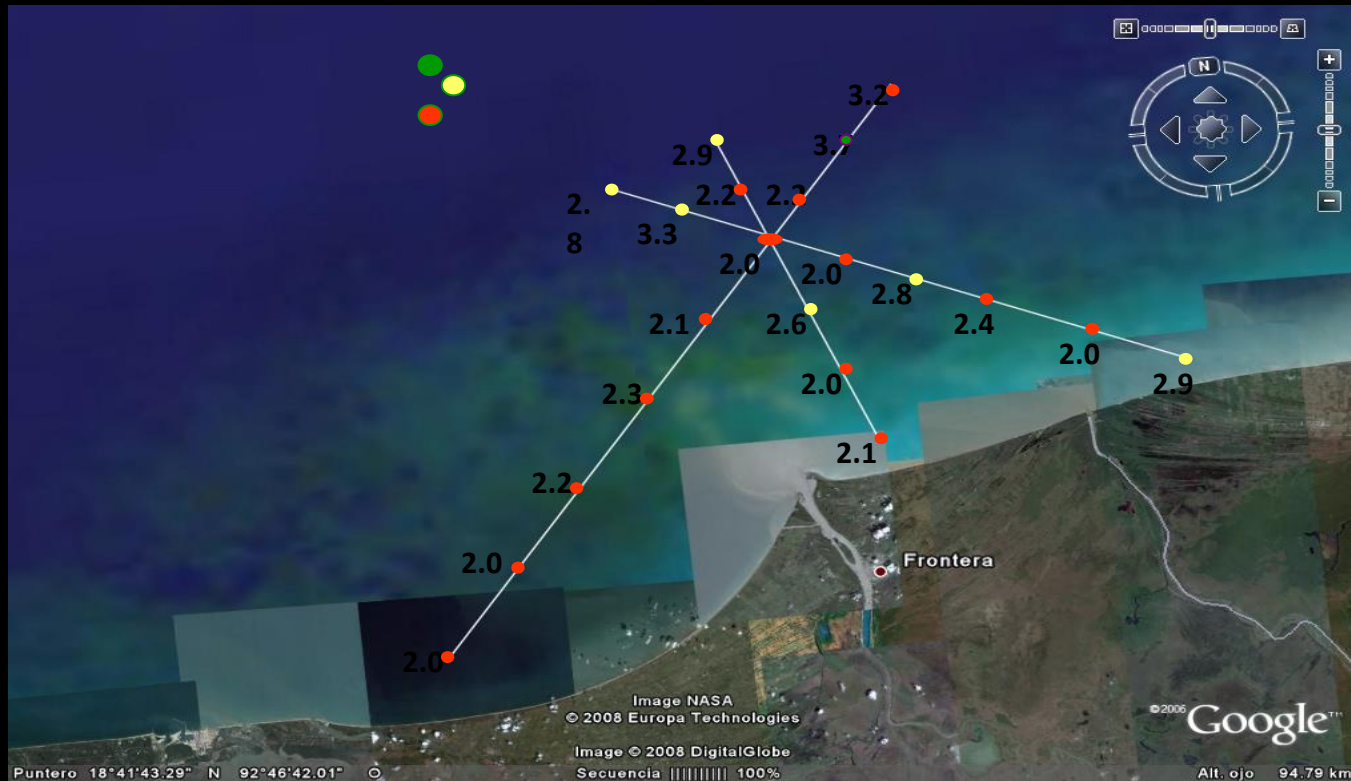
More than 16 cruises over 4 years



PEMEX Cruises

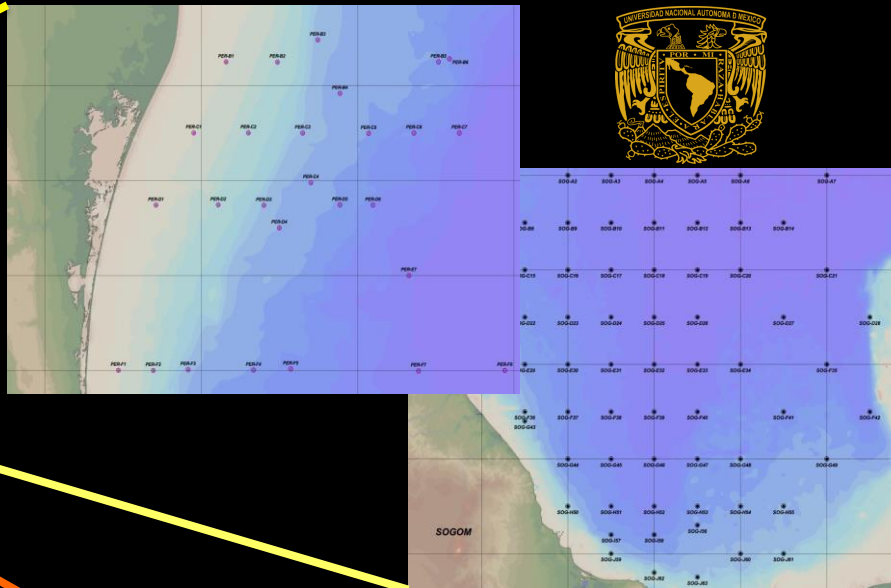
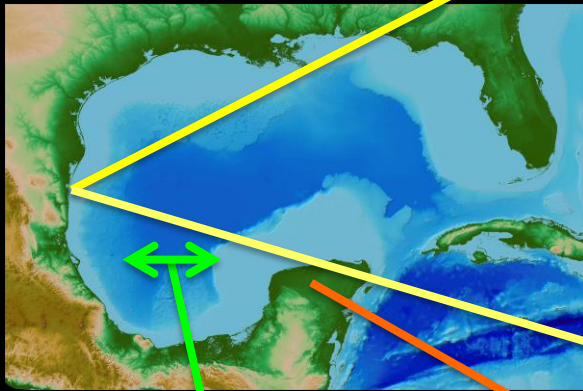


PEMEX Cruises



**River discharge as possible complication

INECC Cruises – Macondo oil spill



C-IMAGE 2

Funded by GOMRI



Southern Gulf of Mexico Coring Plan

Google earth

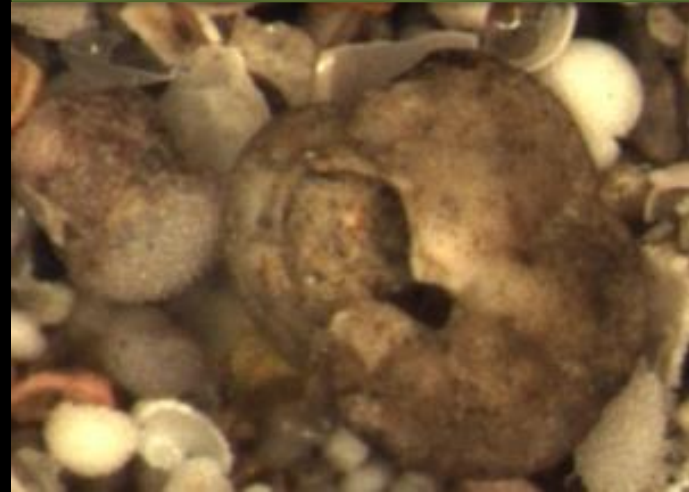
Imagery Date: 4/5/2013 22° 1.237' N 93° 19.523' W elev -3216 m eye alt 897.64 km

Foraminifera

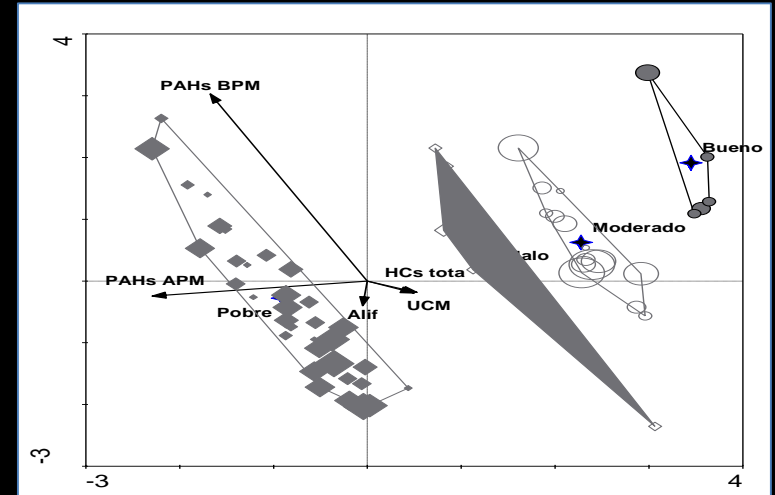
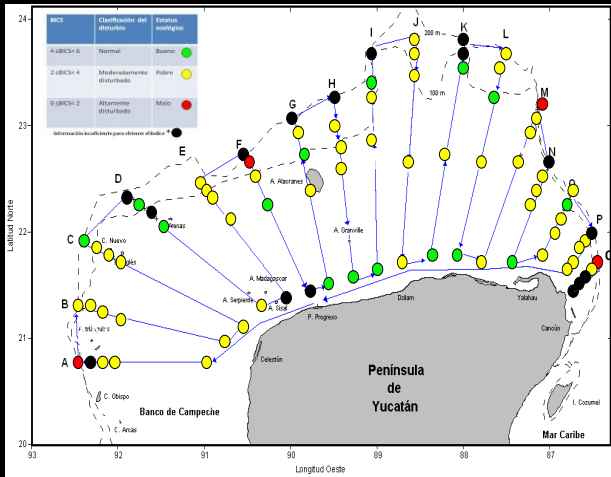
Deformed carapaces



Oiled carapaces



Effects on community structure



Benthic community structure

“Classic” studies using abundance, richness, etc

Adapting BENTIX index to local conditions

- BCIS=Benthic Index for the Campeche Sound
 - Categorized

*Foraminifera are also being used as biological indicators of environmental status

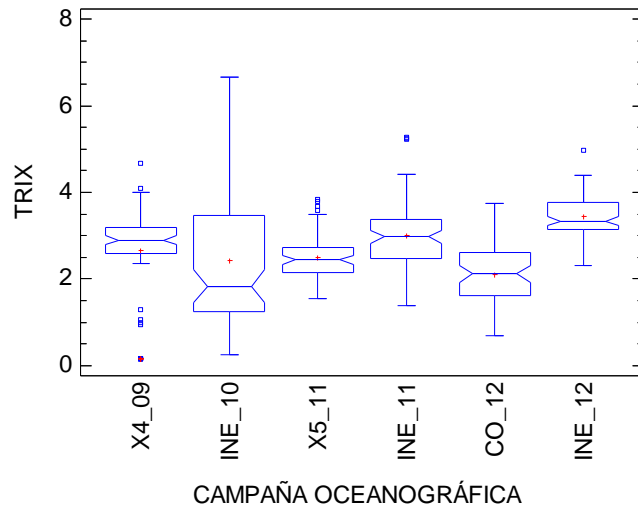
Community structure



Other Tools

Phytoplankton

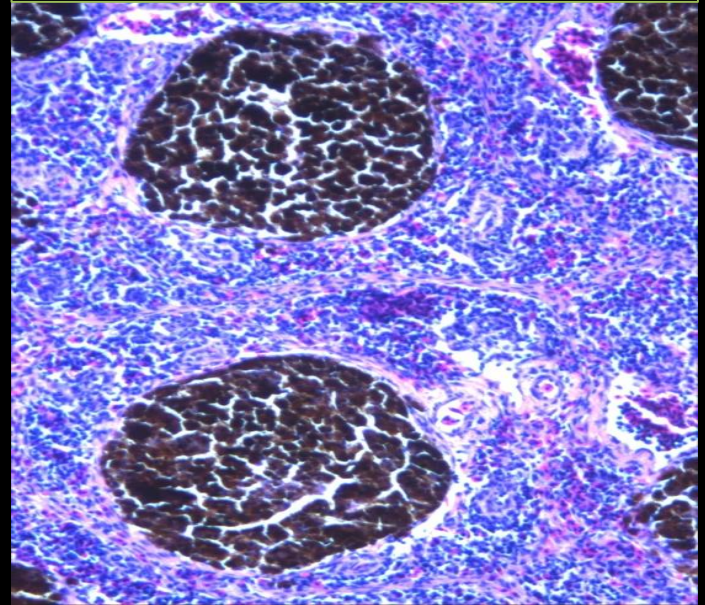
Trophic status



Adaptation of the TRIX index.

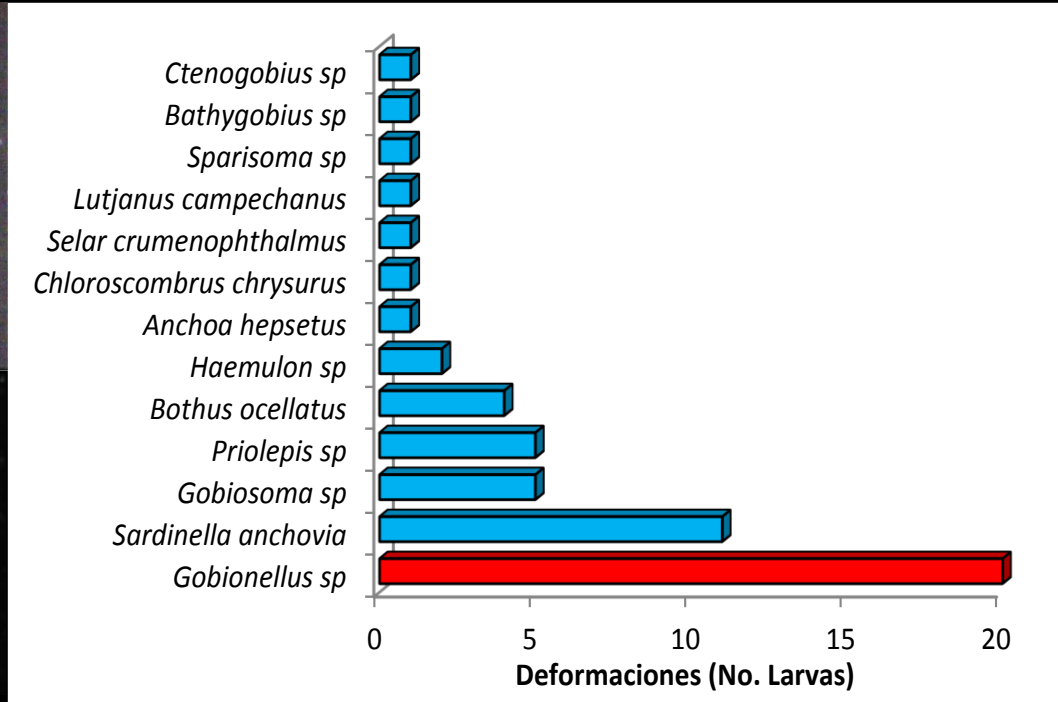
Histopathology

Fish, shrimp, oyster, etc



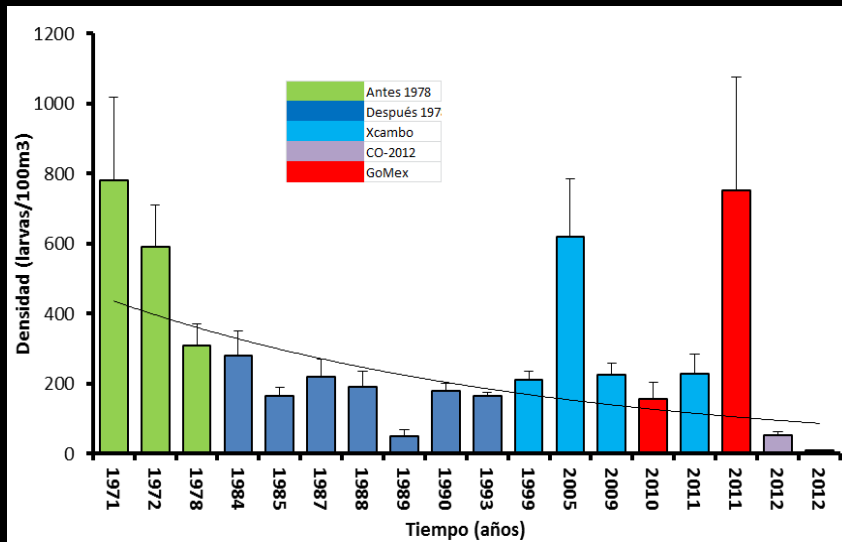
Kidney, liver, spleen, gills

Fish Larvae Deformities

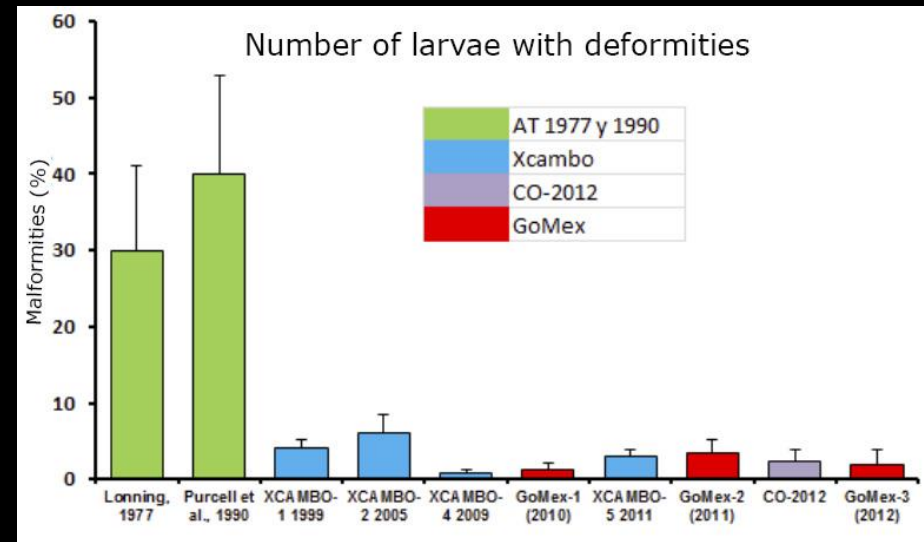


Number of deformities per species and type of deformity

Time Series



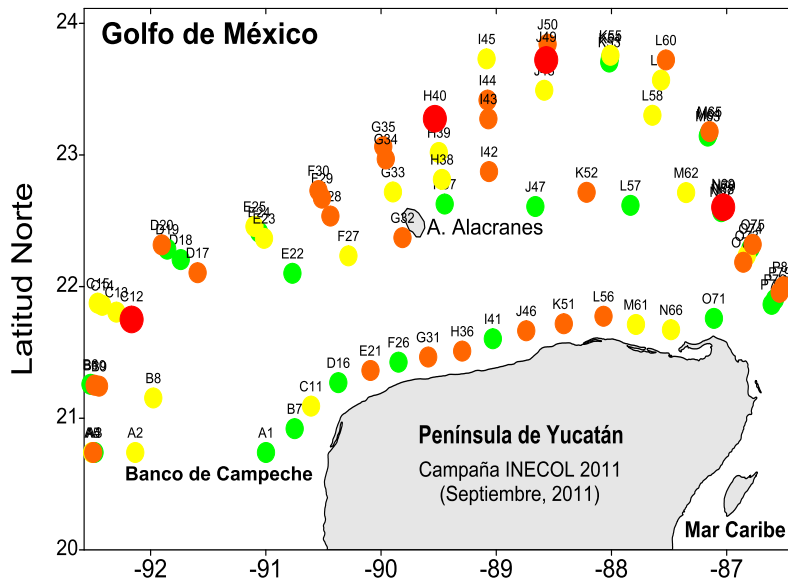
Ichthyoplankton Density (larvae/100 m³)



Larvae with Deformities (%)

Bacteria

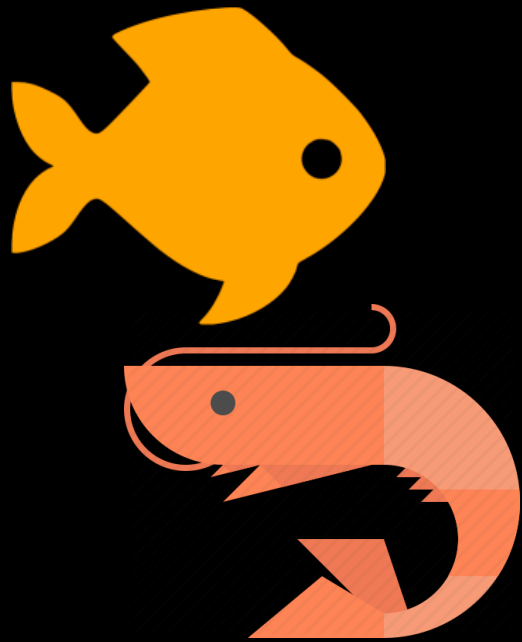
Heterotrophs including hydrocarbon degrading bacteria



Hi/He Index

	% Índice Hi/He	Xcambo-4 (n=80)	Xcambó-5 (n=109)
No afectada	0-1	77 (96%)	96 (88%)
Poco afectada	1.1-6	2 (2.5%)	8 (7%)
Medio afectada	6.1-50	1 (1%)	4 (3%)
Muy afectada	>50	0	1 (0.9%)

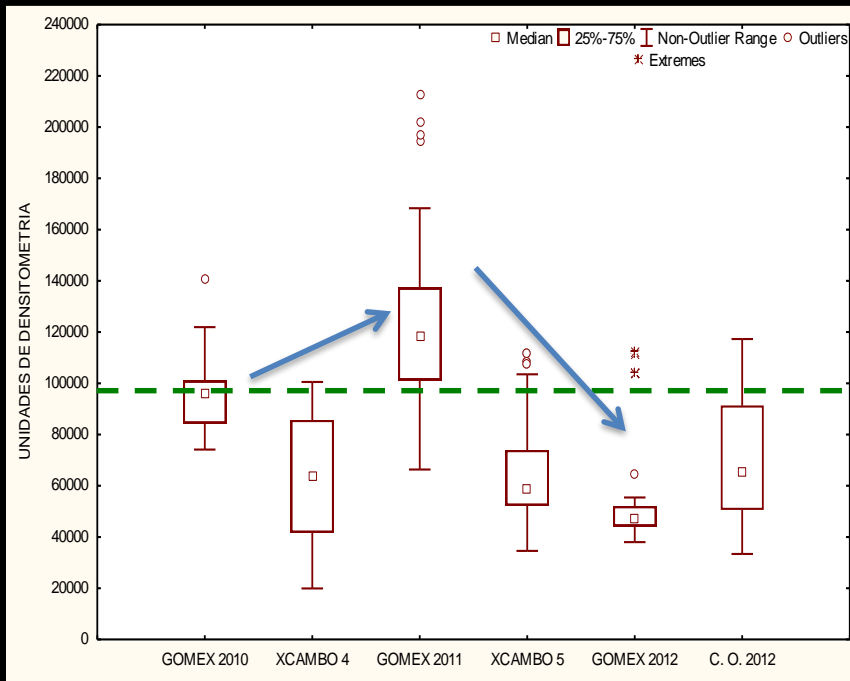
Toxicological Biomarkers



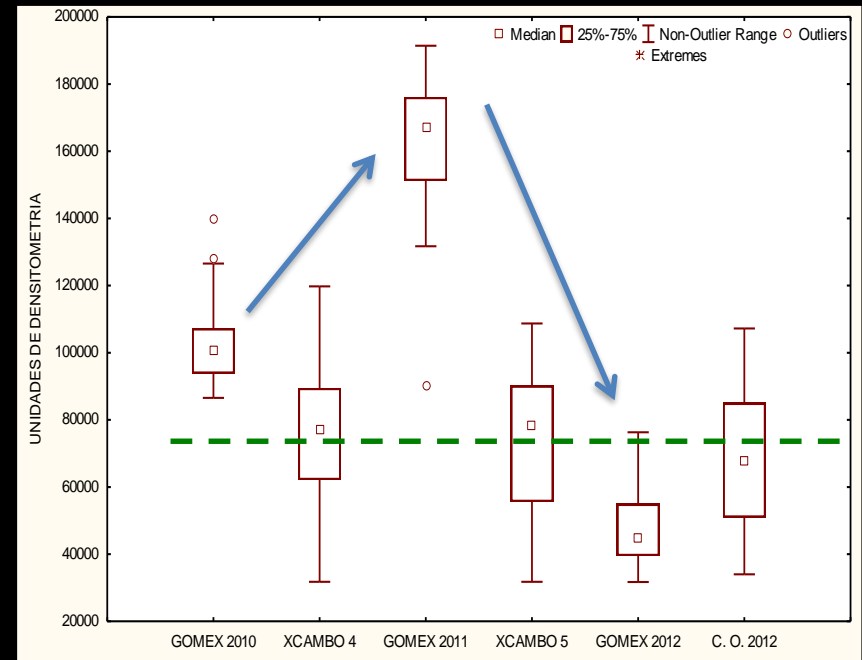
- Transcript abundance (mRNA)
Cytochrome P-450 1A,
Vitellogenin, GsT, etc.
- Enzyme activities:
AChE, EROD, CAT, GsT, SOD, etc
- Concentration of proteins
Vitellogenin, CyP P-450 1A, etc.

Examples

- Increases in 2011
- North Yucatan Peninsula, but not in Campeche Sound



CyP-P450 1A



GsT

Gaps

Epigenetics and metagenomics

Validate Index

Baseline

Different scales

- Fish and other species
- Relationship to pollutants and other factors

Adaptation of the TRIX and BICS

- Effects of natural driving forces vs impact
- Seasonal, annual and decadal changes

Up to the Large Marine Ecosystem scale

Acknowledgments



Sharon Herzka
(CICESE, CIGOM)



Adolfo Gracia
(UNAM)



Omar Zapata
(Cinvestav Merida)



Leopoldina Aguirre
(Cinvestav Merida)



Daniel Pech
(ECOSUR Campeche)



María Luisa Machain
(UNAM)



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...

And many more!

Thank
you!

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Food for Thought

The real wealth of the Nation lies in the resources of the earth — soil, water, forests, minerals, and wildlife. To utilize them for present needs while insuring their preservation for future generations requires a delicately balanced and continuing program, based on the most extensive research. **Their administration is not properly, and cannot be, a matter of politics.**



Letter to the Washington Post
Rachel Carson
US Fish and Wildlife Service
1953