HAB MONOTORING AND MITIGATION IN AQUACULTURE SITES: PRACTICAL EXPERIENCE

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Abstract

- Long term phytoplankton monitoring program is a practical tool to decrease risk of HAB and generates useful information and adequate management. Main results can define critical period, vulnerable areas, as well as inter-annual variability risk associated with meteorological -oceanographic anomalies. In addition, the results can be applied to improve the mitigation techniques, particularly those used in fish farms.
- Harmful Algae Bloom (HAB) caused by *Leptocylindrus* spp., *Ch. convolutus*, *Heterosigma*, Dinoflagellates, etc. present different seasonal and spatial pattern. Their impact depends on the functional group of algae and specie, site conditions, and type of animal in culture.
- Dinoflagellates are more often in summer and early fall, and generate greater impact, however, they have a low frequency appearance. Diatoms are more recurrent in spring, winter and early summer, but with a major frequency and this functional group created lower impact.
- Positive and negative rainfall anomalies have an influence in the frequency and harmful algae species. Most of the events (HAB) occur during negative anomalies, i.e., years with lower rainfall than normal.
- During the time period of analysis, ca. a decade, in general and using an annual basis statistic, the major numbers of events (HAB) per year are directly proportional to the highest negative anomalies observed. The majority of HAB due to flagellates (dinoflagellates and *Heterosigma*) occur during negative anomalies.
- From a practical point of view, oceanographic events and meteorological times series are an important tools to forecast the potential conditions for HAB in the South inland sea of Chile.
- However, the most relevant procedure for the aquaculture industry is the "action" or mitigation techniques to avoid the risk. Therefore, fish farmers are using different site-specific technology to protect the fish biomass, rather than killing or removing the harmful algae from the water.

Introduction

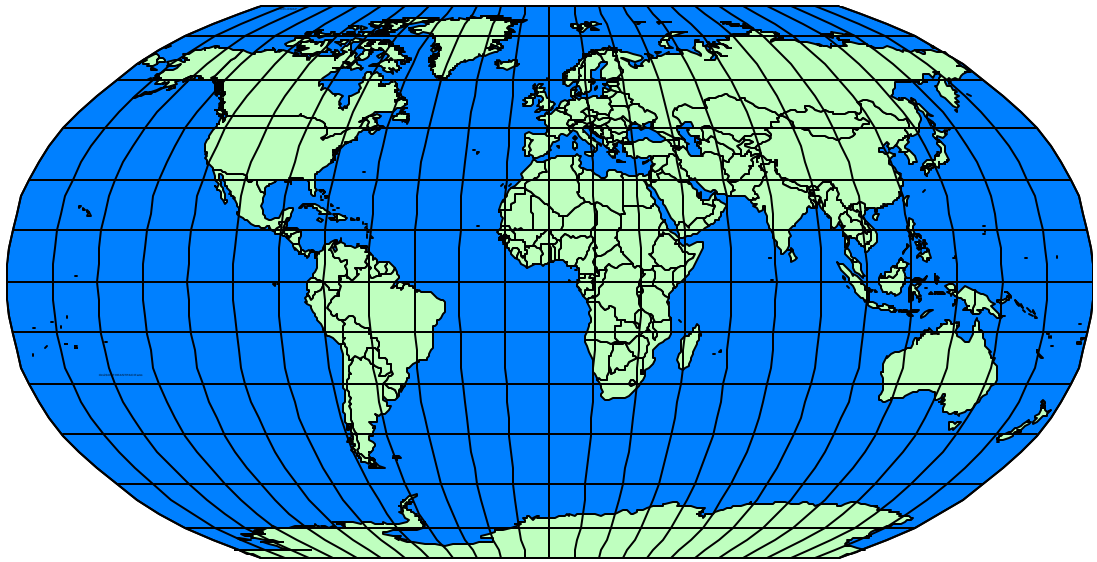
- Long term phytoplankton monitoring program in Chile.
    - Fish farmers program 12 years of data
    - Mollusk farmers program (export UE and USA) 6 years of data
- critical period,
- vulnerable areas
- Inter-annual variability risk associated with meteorological -oceanographic anomalies.
- Improvement the mitigation techniques, particularly those used in fish farms.
- Harmful Algae
    - *Leptocylindrus* spp.
    - *Ch. convolutus*,
    - *Heterosigma*,
    - Dinoflagellates,

    - Temporal seasonal and spatial pattern.
    - Their impact depends on the functional group of algae and specie,
    - site conditions, and
    - type of animal in culture (Sea Trout, Atlantic salmon and Coho).

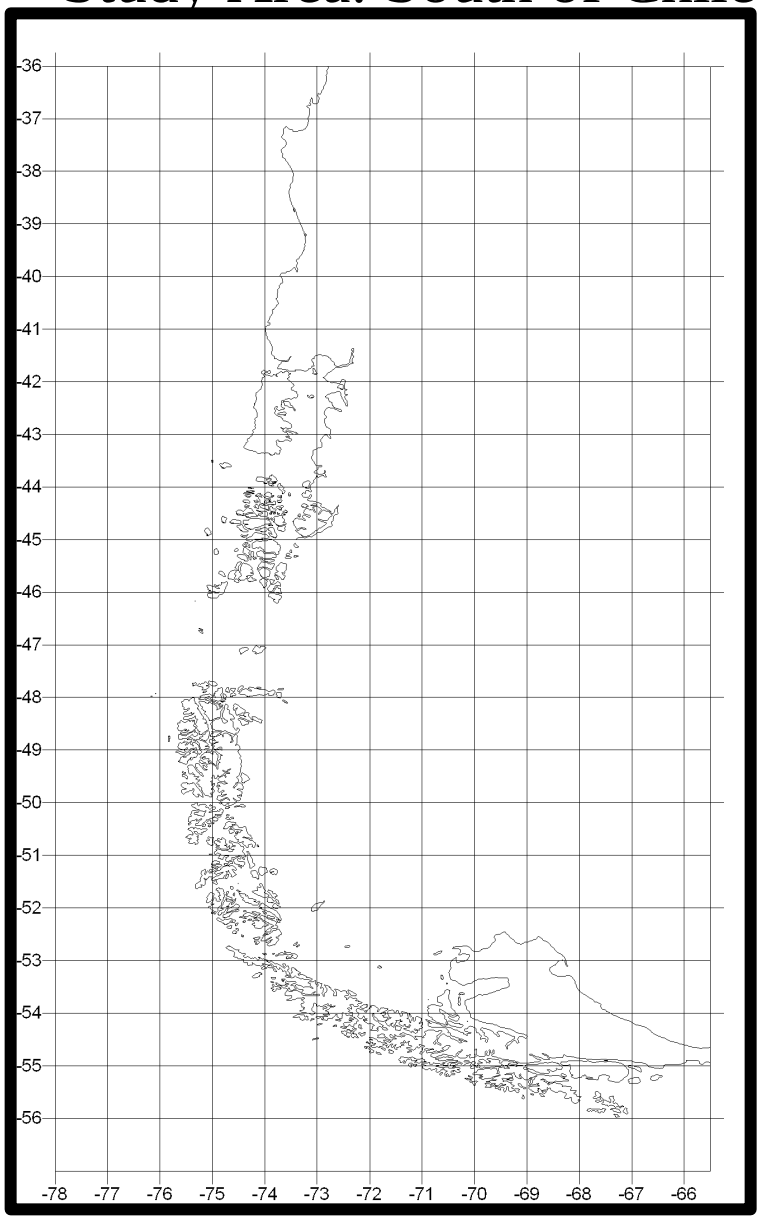
Introduction and Objectives

- **General Objective**:
  - To show to the HAMM2001 scientific and technical community the impacts, monitoring and mitigation activities in an intense marine farming area in the South-Eastern Pacific Ocean.
  - **Specific Objectives**:
  - To identified the most frequent period and areas of the Harmful Algae Blooms outbreaks in the inland sea of the south of Chile.
  - The understand the relationship of HAB events and annual precipitation anomaly in a intense fish farming area, and the use as tool for proper management.

Location



Study Area: South of Chile

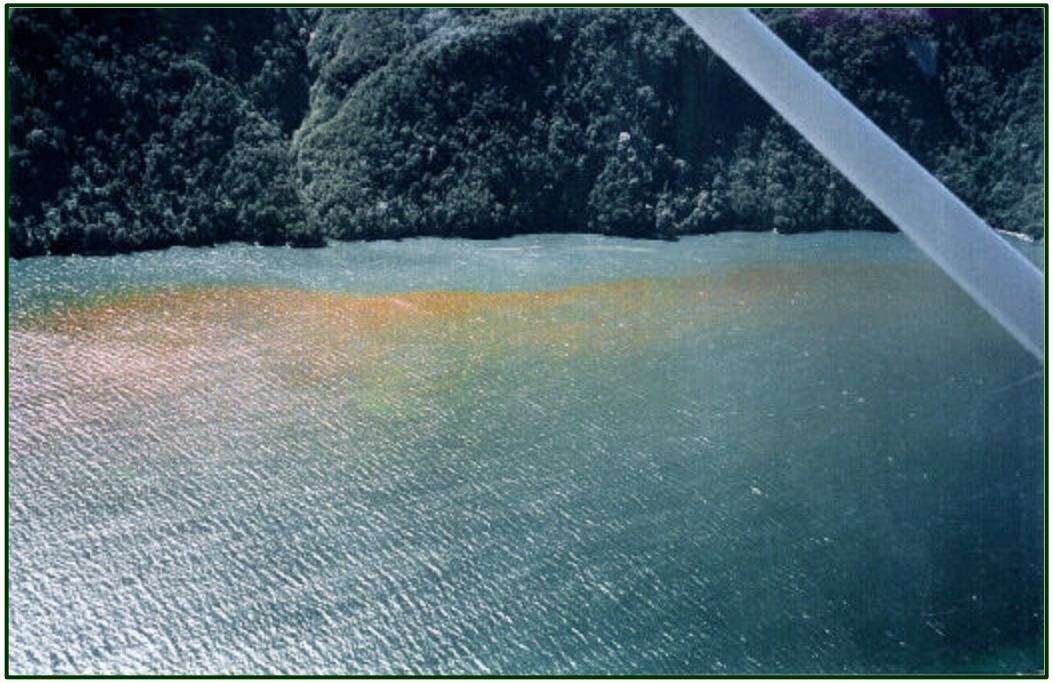


- The X region has the mayor national salmon biomass produced; 2000
- (ca. 260.000 ton)
- XI region biomass produced was around 60.000 ton, but with a great potencial.
- XII region new interest.

Shellfish and Fish Farming in Chile: Mussels, Oyster, Scallops, Seaweed and Salmonid.

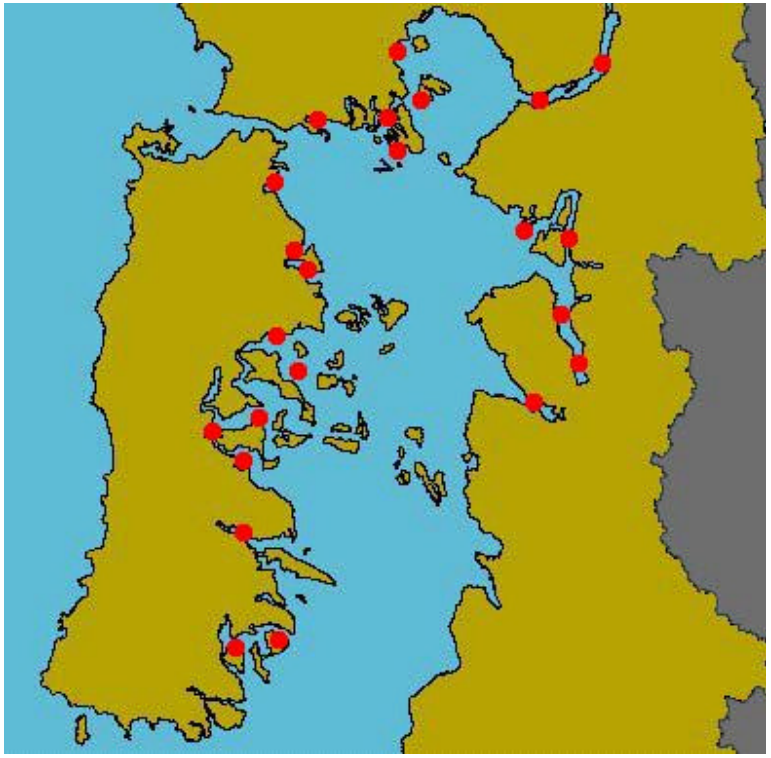
IMPACTS:

LEFT: Filaments near "Peninsula de Huequi". Probably caused by *Heterosigma.* May 3, 2000 DOWN: *Heterosigma* patch



IMPACTS

- Normally harmful diatoms produce moderate impact but they have a very frequent occurrence.
- Flagellates (*Heterosigma* and Dinoflagalletes) produce very severe impact, however they have low occurrence frequency. The exception of this case is within the XI region, where dinoflagellates are frequent and create large impacts (tides, chemical inputs, etc).
- Toxic *Pseudonizschia* cells are a new problem for mollusk farmers, however up to now with low impacts.
- Main farms sites are not affected significantly by PSP and DSP because are located in different geographic areas.

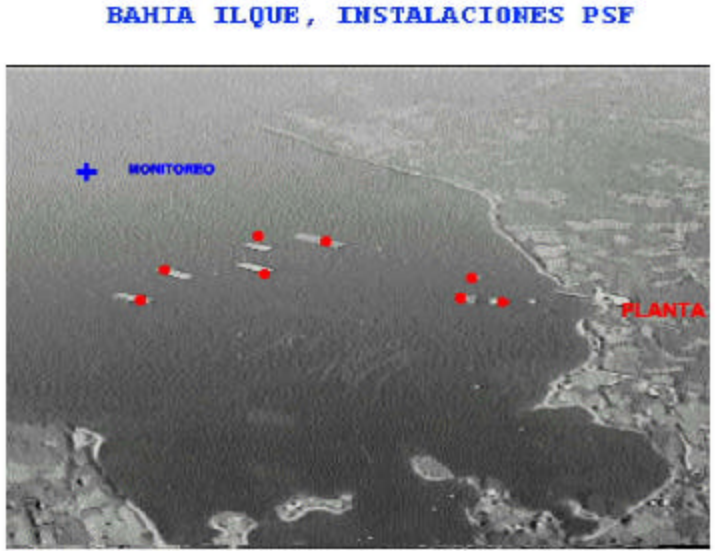


Monitoring

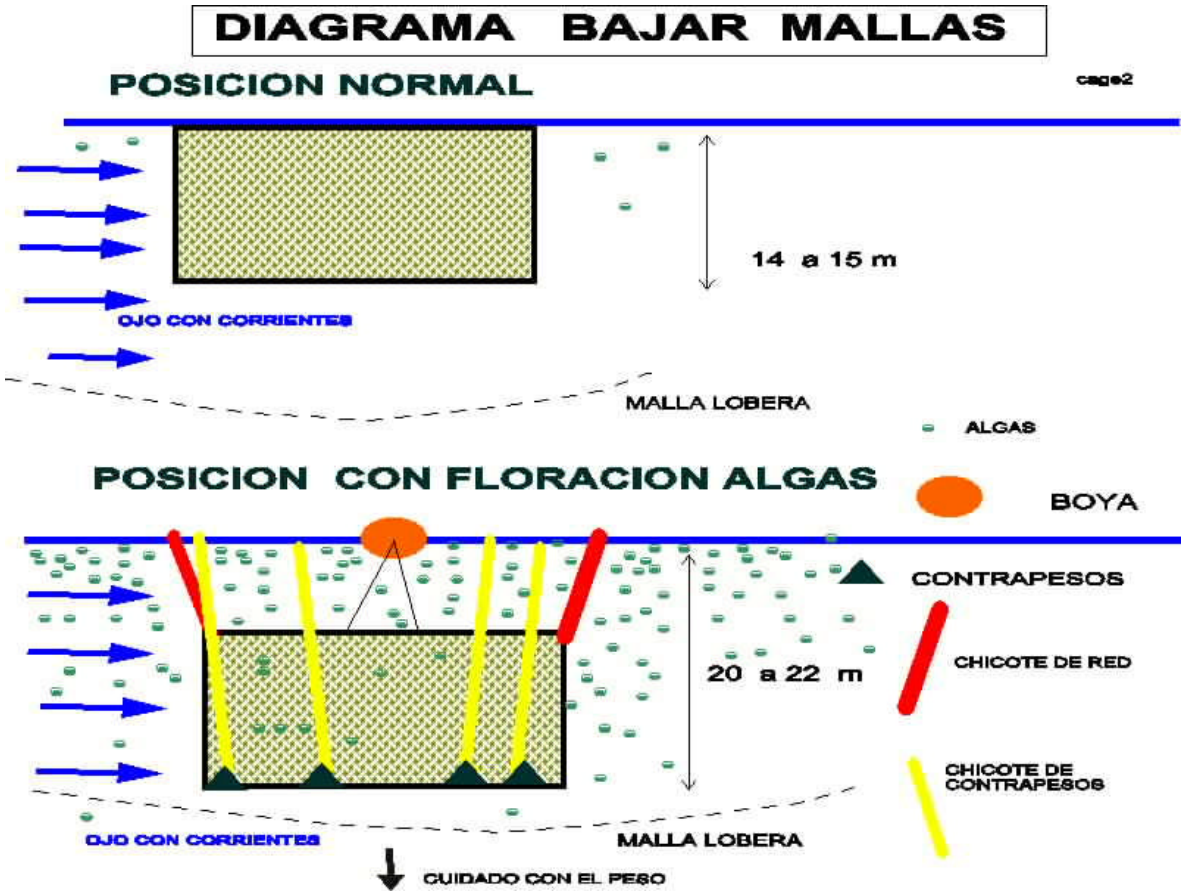
- To develop a practical tool for an adequate management of the fish and shellfish at the production sites when a HAB occurred
- Twenty stations within the Inland sea
- Live or fresh samples analysis.
- Abundance and composition
- Sampling frequency : 10 days
- Collection of oceanographic and environmental data.
- Results are given “almost in real time” via Internet and fax.
- Access Data Base and Arc View.

Mitigation Techniques

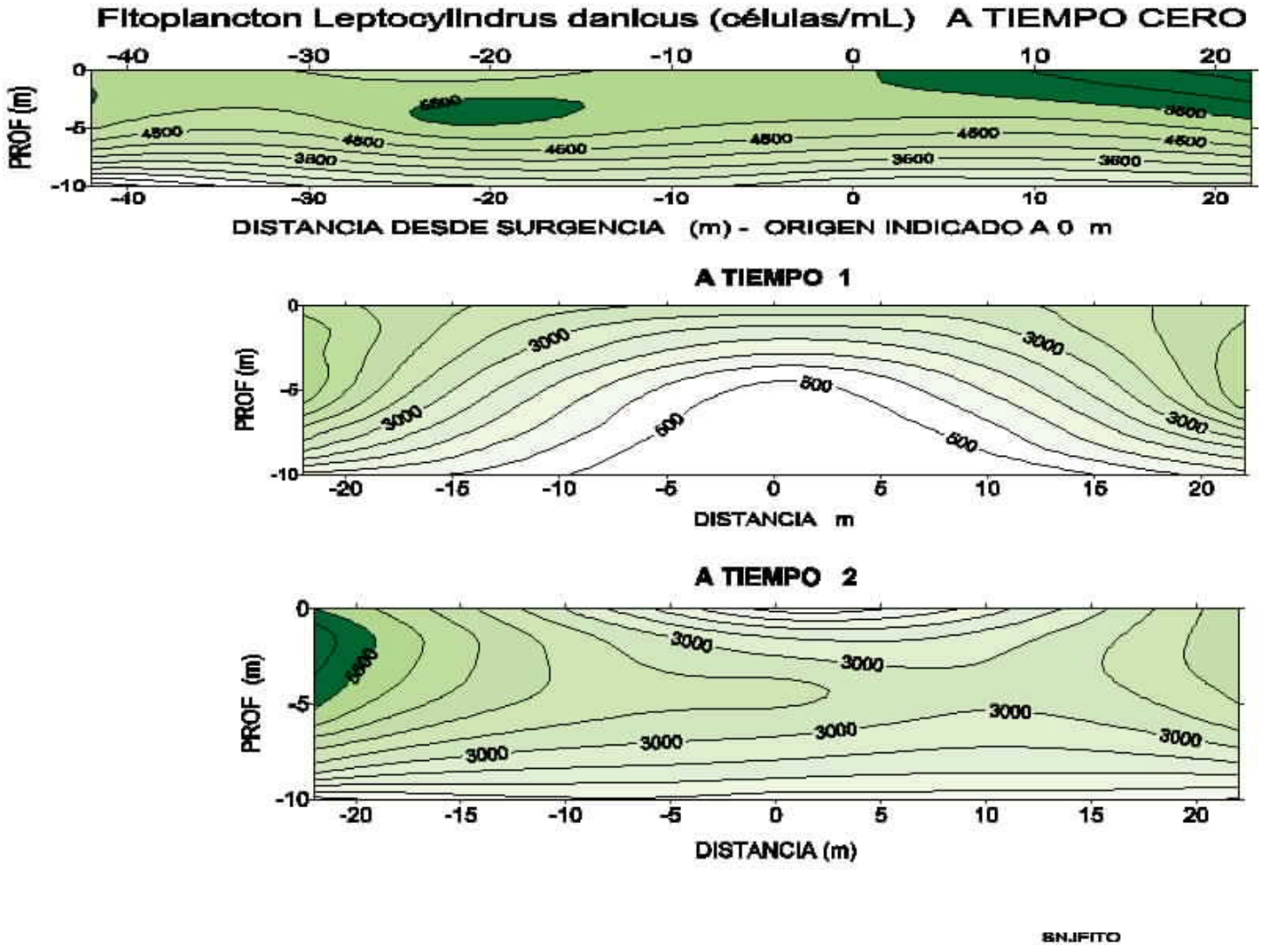
- Bloom features and type of algae
- Technical support and monitoring
- Infrastructure and type of cages
- Oceanographic features of the sites
- Specie, Number and biomes of fish
- Human resources
- <u>Practical actions In Chile</u>
  - Plankton Tarp
  - Mechanical Upwelling device
  - Air pumping
  - Cage transport
  - Submerging Nets
  - Extra materials (surface net, weight, ropes, buoys)



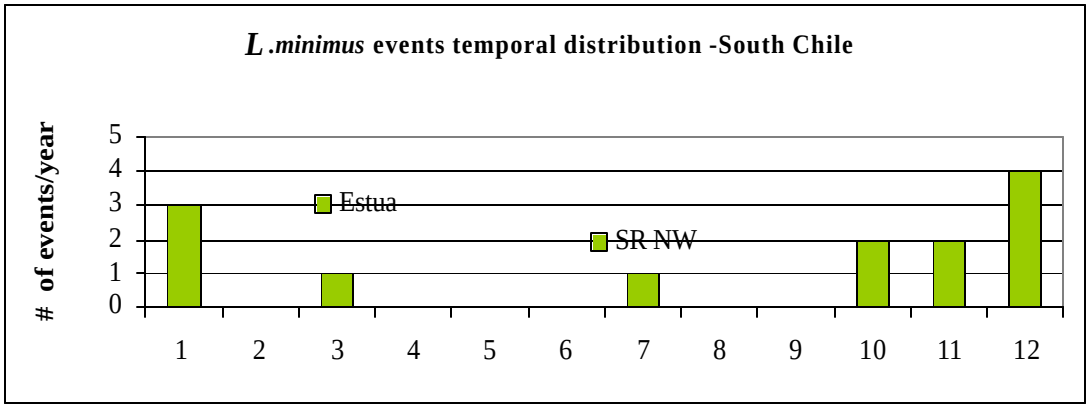
Mitigation Techniques

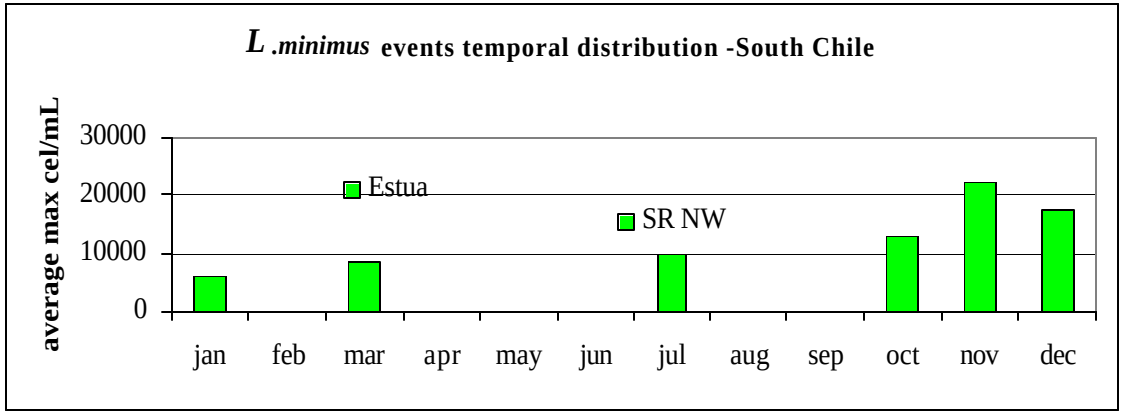


Mitigation Techniques



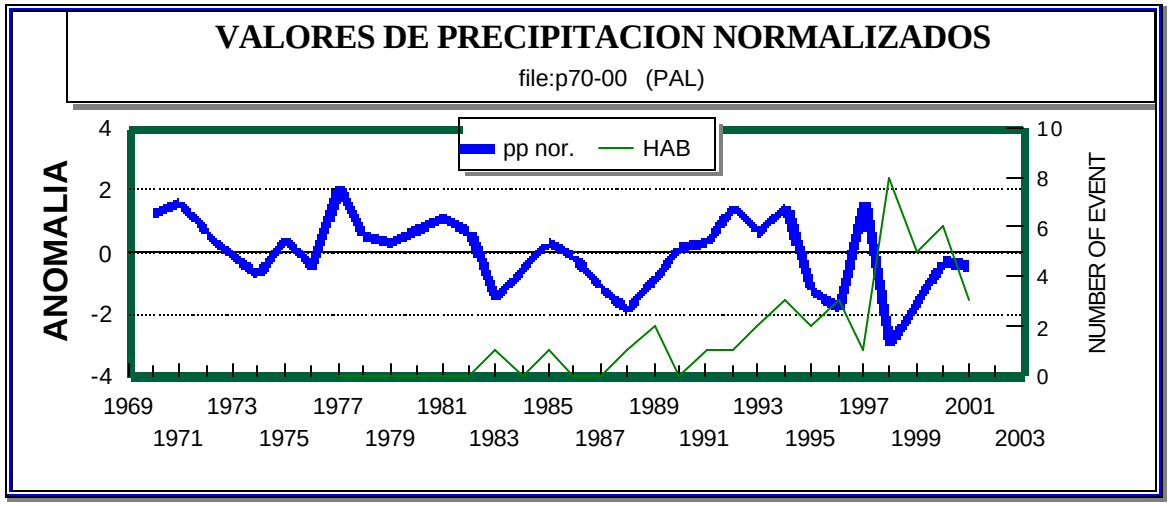
Example: Critical period of *L.minimus;* graphs show period of HAB causing fish mortality, representation correspond to events/year and cell concentrations in function of time.

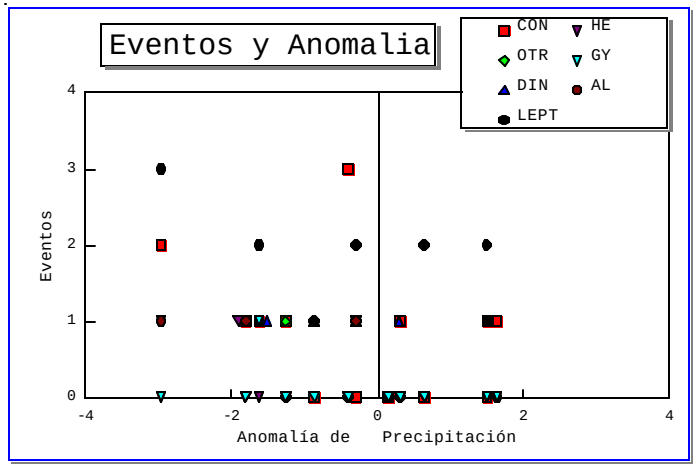


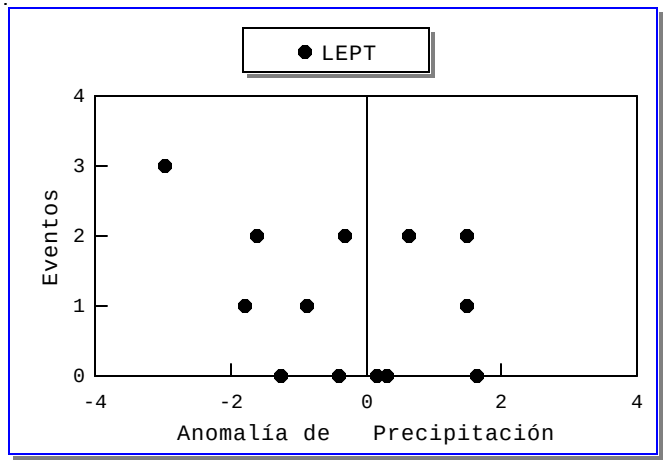


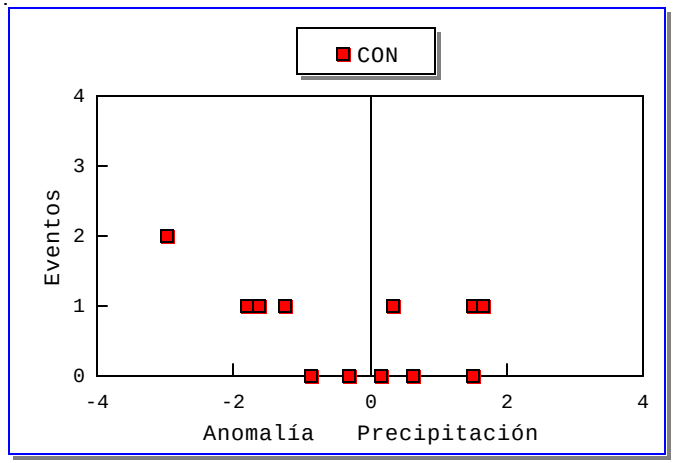
- Long term phytoplankton monitoring: results of 12 years define the critical period and risk areas for this diatom, in the inland sea of the south of Chile.
- Spring and early summer, depending the latitude is the most possible scenario for a HAB of *L. minimus* . It blooms almost every year.

HAB precipitation anomalies

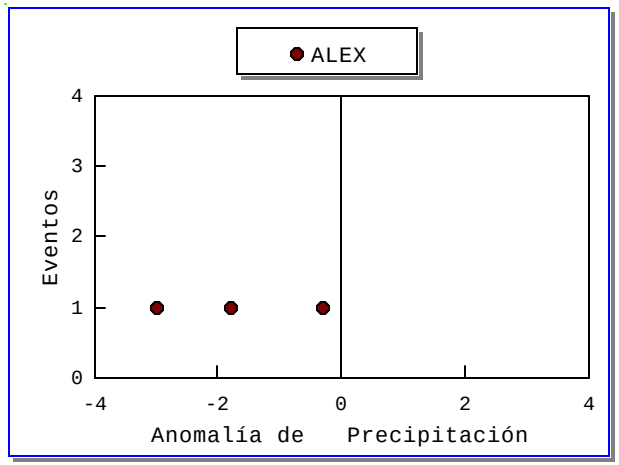


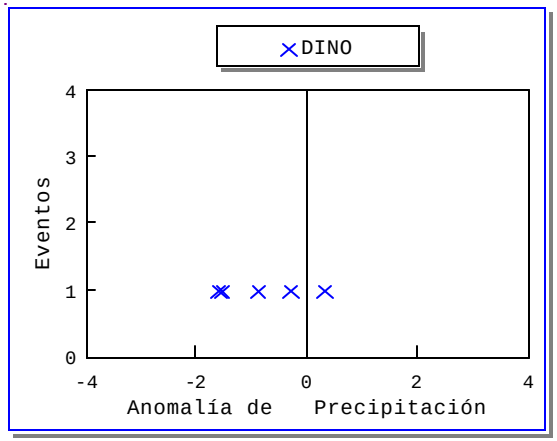


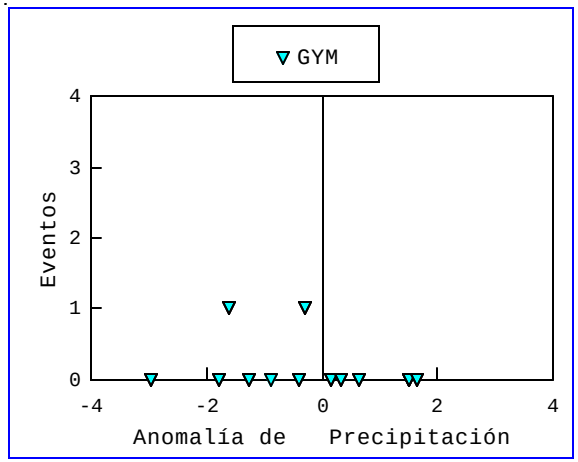


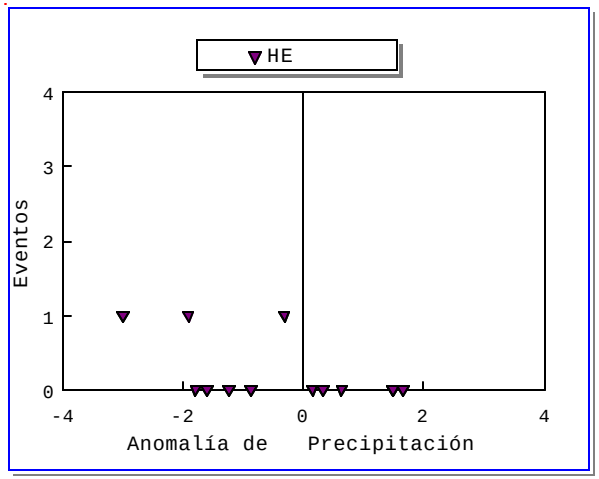


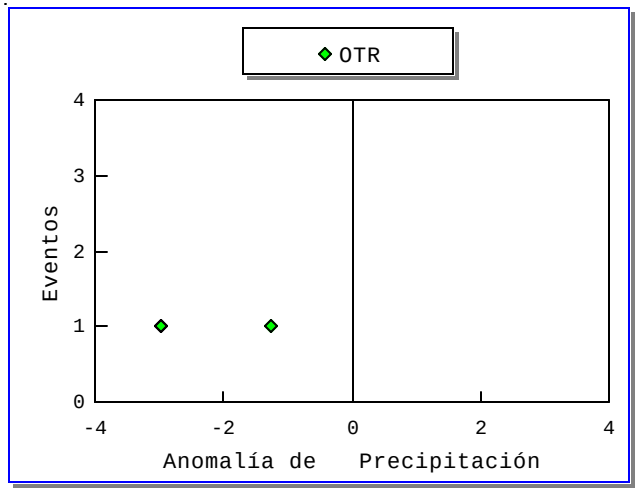
HAB precipitation anomalies











Short term Future Requirements

- To Improve Mitigation:
  - More knowledge of HAB oceanography, phytoplankton biology and ecology.
  - More empirical support with specific applied technology
  - Financial support, leasing, renting, etc
  - Services
- To Improve Monitoring:
  - Almost real time results: marine mobile lab. (terrestrial and marine)
  - Electronic sensors; lower price and better quality
  - Data base records, appropriate software
  - Documentation, GIS and Internet communications

Final Remarks

- Phytoplankton monitoring programs require a faster response time; the use of technology such as an *in situ* pigment profiling sensor or other biological markers is a challenge issue. Specific database software for archive and analysis large amount of data is also an important requirement. There is an great opportunity to disseminate results via internet, despite most of the "aquaculture sites" do not have connection, however, we expect than in the next 3 to 4 years most of them will have access to internet.
- We believe from an environmental, technical and economical point of view, that at a local level and due to fish farmers floating infrastructure is better to use site-specific-mitigation techniques rather than "attacking the bloom itself".
- In general, HAB frequency and occurrence depend on the annual precipitation anomaly in the inland sea of the south of Chile (Temperate and rainy - climate).
- As the precipitation anomaly decreases (negative anomaly, i.e. less rain than a normal year) the possibilities of an HAB increases.
- The results show that HAB do not occur in years with anomalies greater than 2 (rainy years), and on the other extreme, the most severe harmful blooms occur with negative anomalies.

  During the time period of analysis all the harmful flagellates (dinoflagellates and *Heterosigma*) blooms occur exclusively during (-) anomalies.