Foveaux Strait Ecosystem Management Workshop

Invercargill

August 2004

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Agenda

- Welcome and introductions
- NIWA presentation
- Review of proposed research
- Discussion
- Summary

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Overview

- Ecosystem management & goals
- Historical overview of research
- Foveaux Strait as an ecosystem
- Ecosystem relationships
- FRST research
- Links to the case study and other research
- Collaboration and critical factors for success
- Tools and information for management

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Ecosystem management & goals

- Ecosystem management recognises the relationships between shellfish and fish populations, habitat, and associated species
- Fisheries production is linked to maintaining critical relationships within these ecosystems
- World wide ecosystem management is acknowledged as the next generation of fisheries management (Fisheries Act 1996)
- Case study of ecosystem management in Foveaux Strait oyster fishery area

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Ecosystem management & goals

- Aim of case study to provide knowledge and tools to underpin management goals:
  - To increase the sustainable production of oyster and blue cod stocks, and the regeneration of benthic habitat
  - By developing the capacity to evaluate strategies for proactive management

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Ecosystem management & goals

- Case study divided into two interlinked investigations:
  - Developing adaptive fish stock management strategies (BOMC, blue cod fishers and MFish)
    - Tools for evaluating management options (predictive capacity)
    - Ecosystem management based on co management of fish stocks and habitat on a small spatial scale through structured fishing
  - Developing strategies to mitigate and remedy the effects of dredging (FRST) through understanding processes and critical relationships

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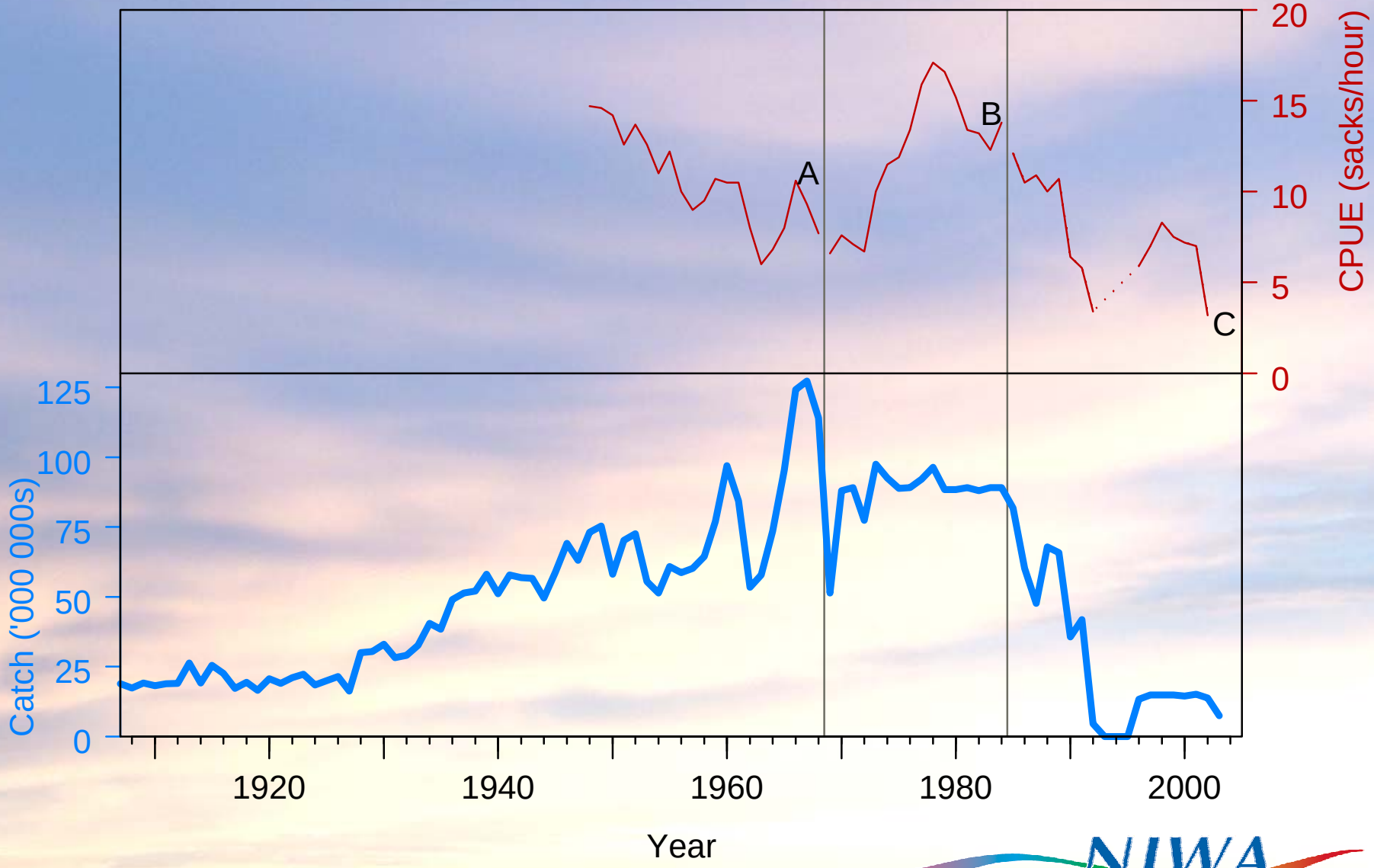
Historical overview of research



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Historical overview of research

Oysters

- Population surveys, 1906–2004; 1906, 1926–27, 1960–71, 1974–76 (distribution), and 1990–2004 (comparable population estimates)
- Bonamia surveys 1986–95 and 2000–04
- Biology, 1960–77 and 1999 –2000
- Ecology 1950–99 (observations)
- Effects of fishing 1997–2004

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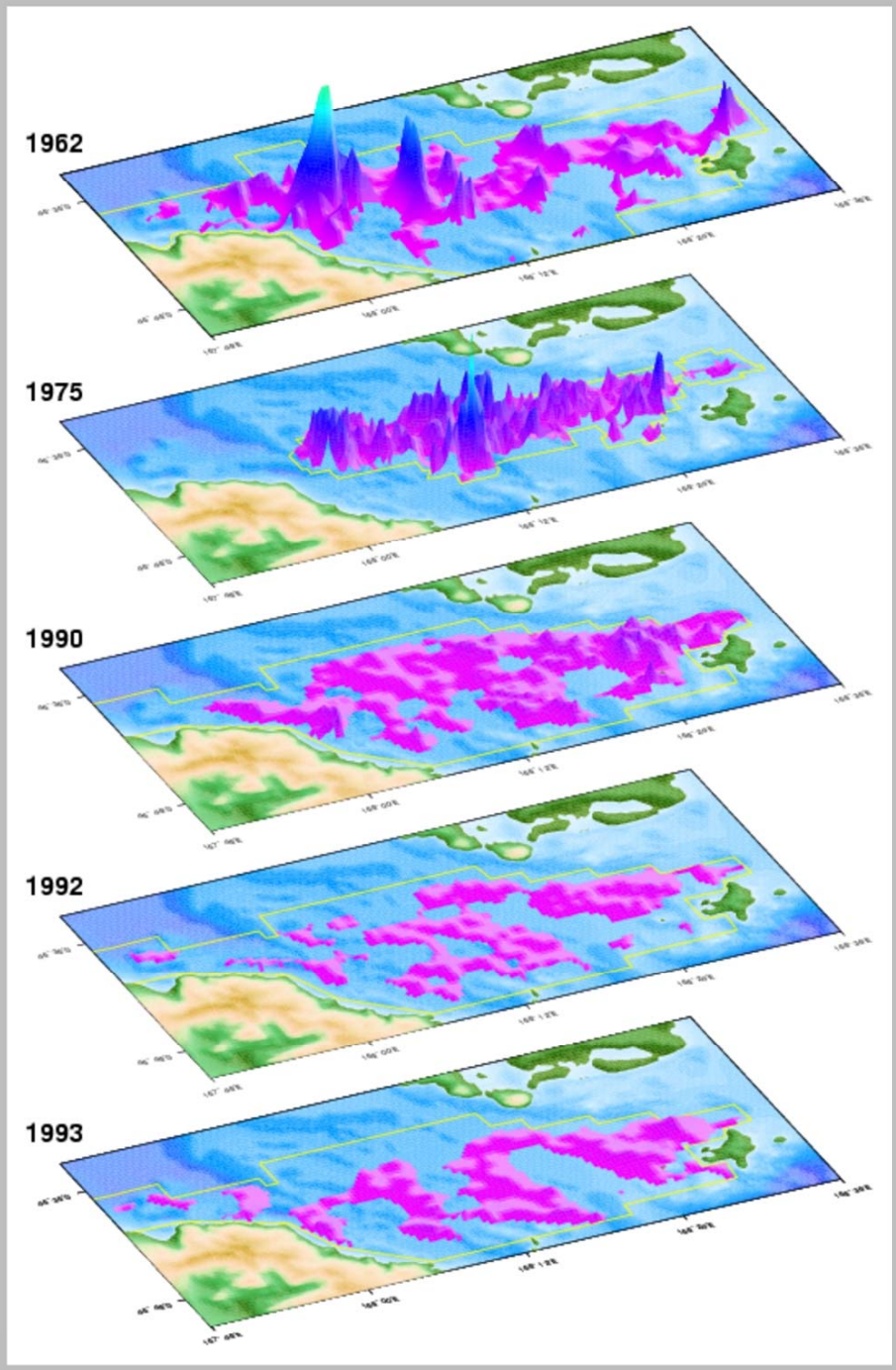
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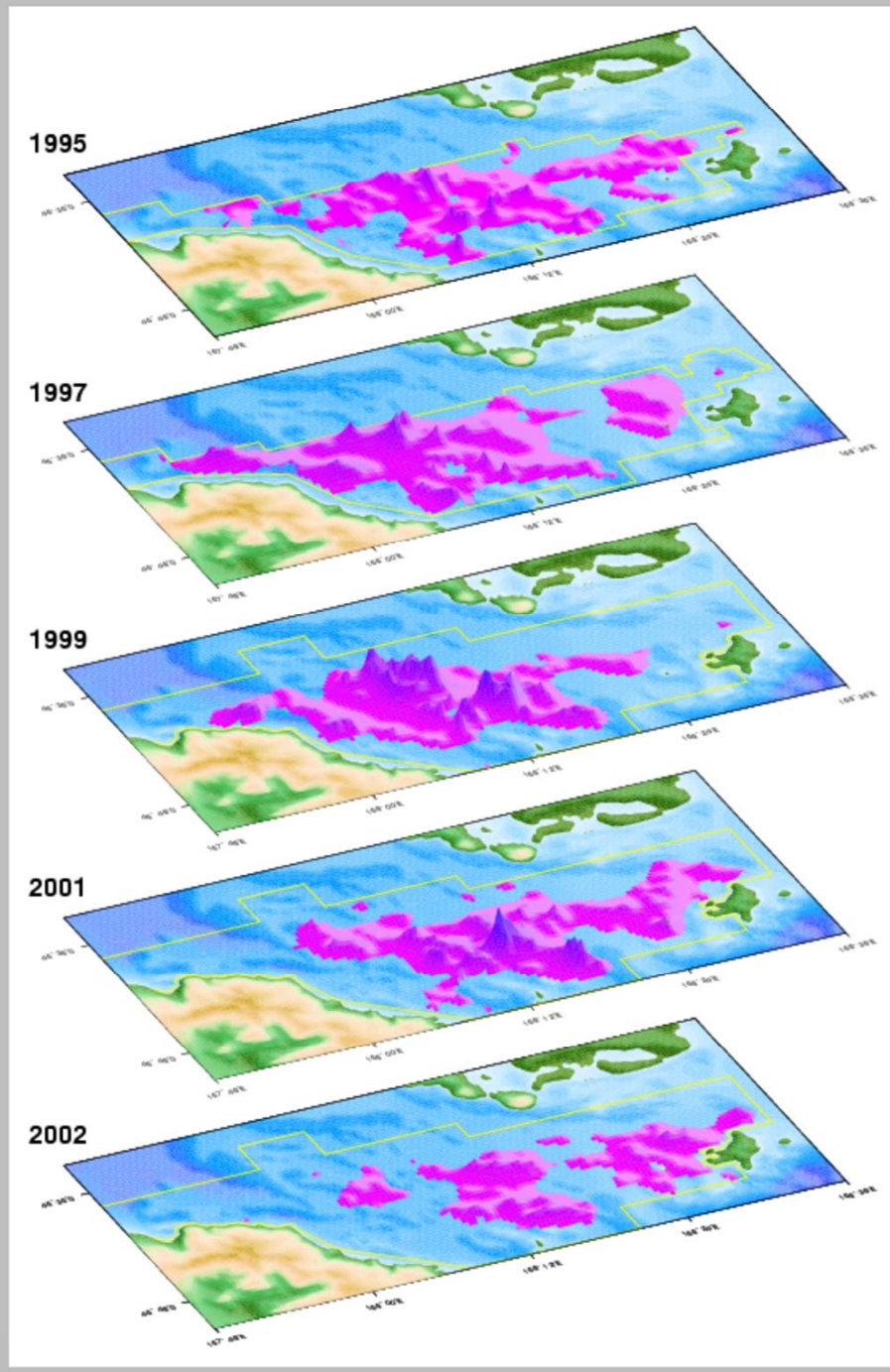
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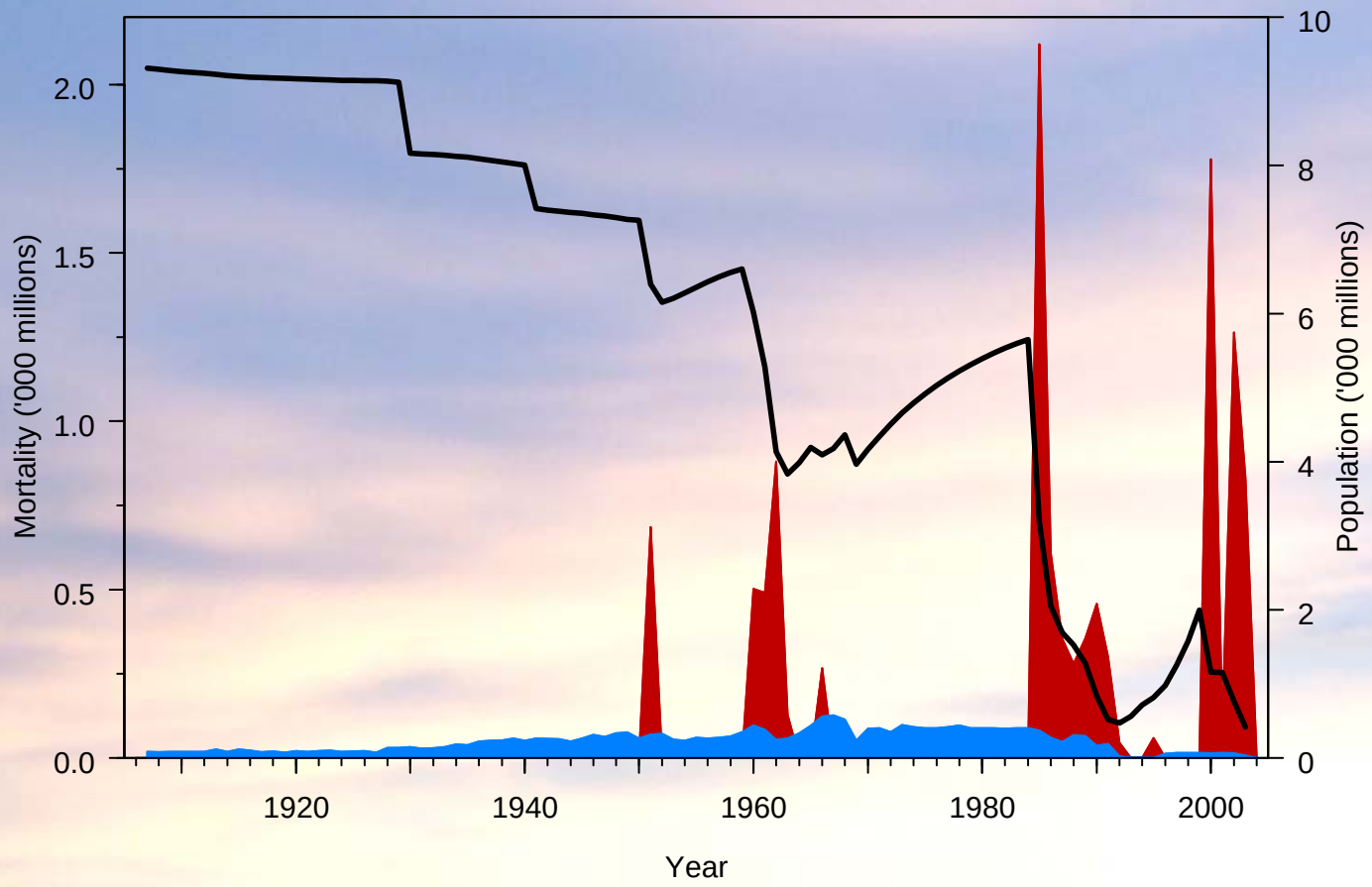
Historical overview of research



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Historical overview of research

Oyster spawning

- Protandrous hermaphrodite (both male and female gonads)
- Spawn as males first then as males and females at 50 mm (could self fertilise)
- Larger oysters produce more ova
- A small portion of the recruited population spawn as females (up to 12%) each year, but 70–90% spawn as males

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Historical overview of research

Bluff oyster spawning

- Spawning peaks in the spring and summer, although they may have protracted spawning
- Spawning occurs at 9-10°C in Foveaux Strait
- Larvae are incubated for 24–30 days
- Mean proportion of oysters incubating larvae range from 1–6 % in September to December and highest reported to be 8.5%
- Early stage planktonic larvae found in 1989
- *No studies of the gametogenic cycle of oysters in Foveaux Strait*

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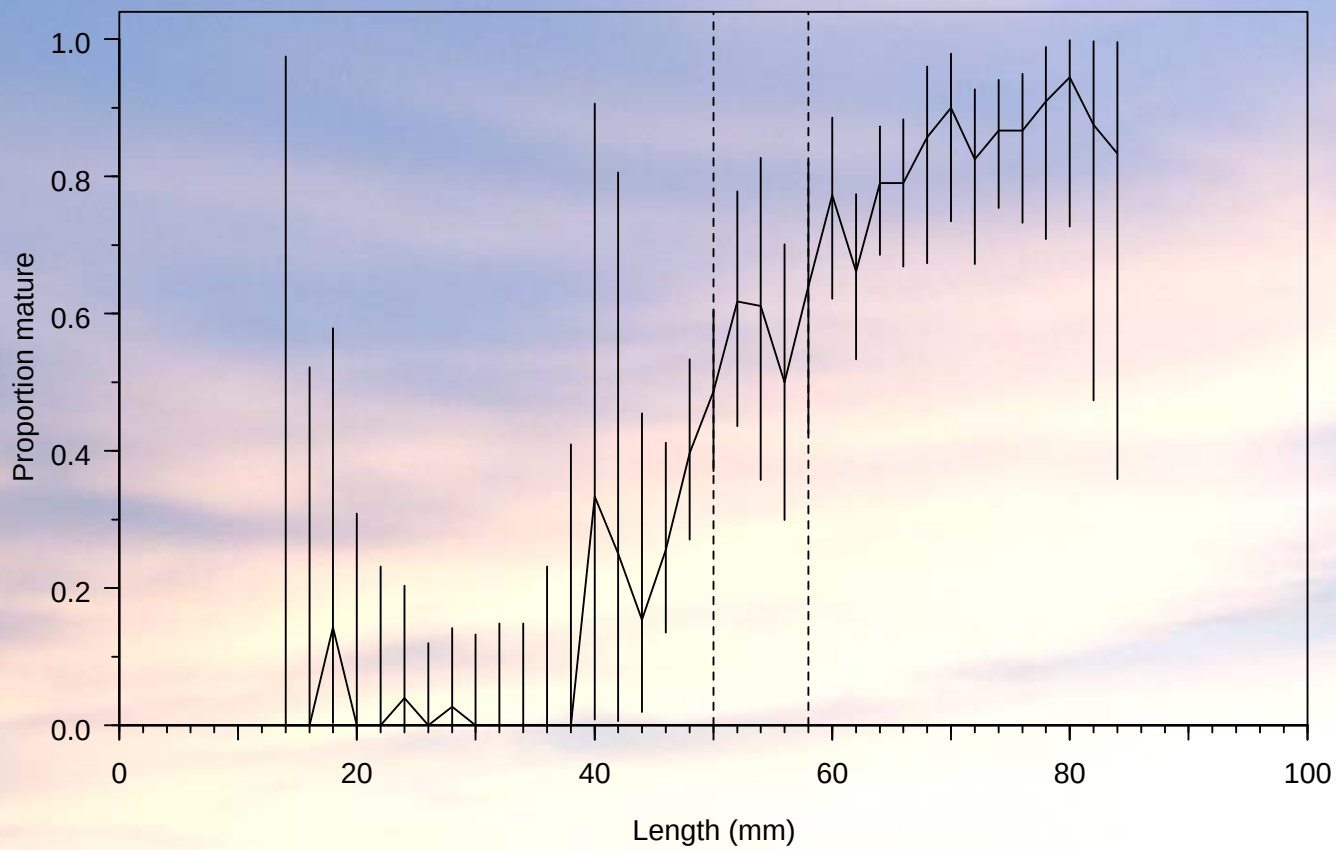
Historical overview of research



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Historical overview of research

Bluff oyster settlement

- Peak period for settlement mid December and mid February (80–90%) with some settlement October to July
- Oysters settle mainly on live oysters, oyster shell and circular saws (*Astraea heliotropium)*
- Thought to mainly to settle near source populations, but some research suggest wider dispersal of planktonic larvae and that settlement may be settlement surface limited

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Historical overview of research

Bluff oyster settlement

- Early observations of oysters in unfished areas found mainly on sandy gravel substrates with sand although oysters were a significant component of biogenic reefs
- There are no studies on the role of planktonic larvae or large-scale larval dispersal to recruitment processes

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168° 0' E
168° 20' E
SOUTH ISLAND
Bluff Harbour
Dog Island
46°40' S
Black Rock Point
Saddle Point
Garden Point
Ruapuke Island
STEWART ISLAND
46°50' S
Patterson Inlet

Historical overview of research

Bluff oyster growth and mortality

- Growth to legal size similar, but maximum size may be determined by habitat
- Oysters grow to legal size in 4–8 years
- Natural mortality of spat high, but low for 2 year old and older oysters in the absence of disease and other mortality
- Mortlaity from Bonamia thought to be higher in large oysters reabsorbing ova

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Historical overview of research

Benthic habitat

- No historical snapshot or baseline for whole fishery area
- Observations 1950, 1960, and 1990
- Bycatch 1990–2004, but no comprehensive fishing history
- Side scan 1978–79 and 1998–99

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Historical overview of research

Effects of fishing:

- Incidental dredge mortality 1997
- Bycatch composition 1999
- Changes in habitat complexity and settlement 1999–2000

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Historical overview of research

Bonamia

- Endemic and suspected mortality reported as early as 1906, confirmed in tissues from 1963
- Do not know what triggers epizootics
- Transmission of Infection
  - By infective particles oyster to oyster
  - No spore stage known, 2-4 days in water column
  - Spread of infection very rapid in areas of high oyster density
  - Intensity of infection exacerbated by stress and high temperatures (15°C)
  - Reduced by lower salinity

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Historical overview of research

Bonamia

- Infective particles filtered from seawater during feeding, passing through the gut to blood stream and blood cells
- Bonamia multiplies rupturing cells, exhausting oysters energy reserves leading to death
- Mortality can be 40-65% for recruited oysters and can be size dependant, small oysters and spat killed in high density areas with high infection

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Historical overview of research

Knowledge gaps:

- The impacts of dredging intensity and frequency on benthic habitat change and regeneration
- A detailed understanding of habitat fish down and regeneration and colonisation processes
  - Physical changes; structure, stability and complexity
  - Colonisation of benthic fauna
    - Sources of reproductive propagules
    - Spatial and temporal variation in species colonising fished areas

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Historical overview of research

Blue cod

- Characterisation 1997
- Biology; age, growth, reproductive 1994-1998
- Tagging; movement & stock mixing 1998-2001
- Fishing mortality (pots & hooks) 1999
- Dive surveys of shallow reefs 2001-2002

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Historical overview of research

Impacts of habitat change from dredging on blue cod

- Historical fisheries interactions 2001
- Diet 1999-2002
- Growth 1999-2003
- Benthic fish population changes (DUV) 2001-ongoing
- Juvenile mortality in relation to benthic habitat complexity 2003-2004

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Foveaux Strait as an ecosystem

- Little know about Foveaux Strait as an ecosystem and the critical factors that influence its function:
  - Dynamic physical environment
  - Effects on benthic habitat
  - Temporal and spatial variation of benthic communities
  - Investigated aspects of the ecosystem but not the relationships that drive them

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Foveaux Strait as an ecosystem

- Need to determine critical relationships between dredging, and oyster and blue cod production, oyster mortality from Bonamia, and benthic habitat
- Fishery scale experiments important so that results from research can be directly applied to the development of management strategies

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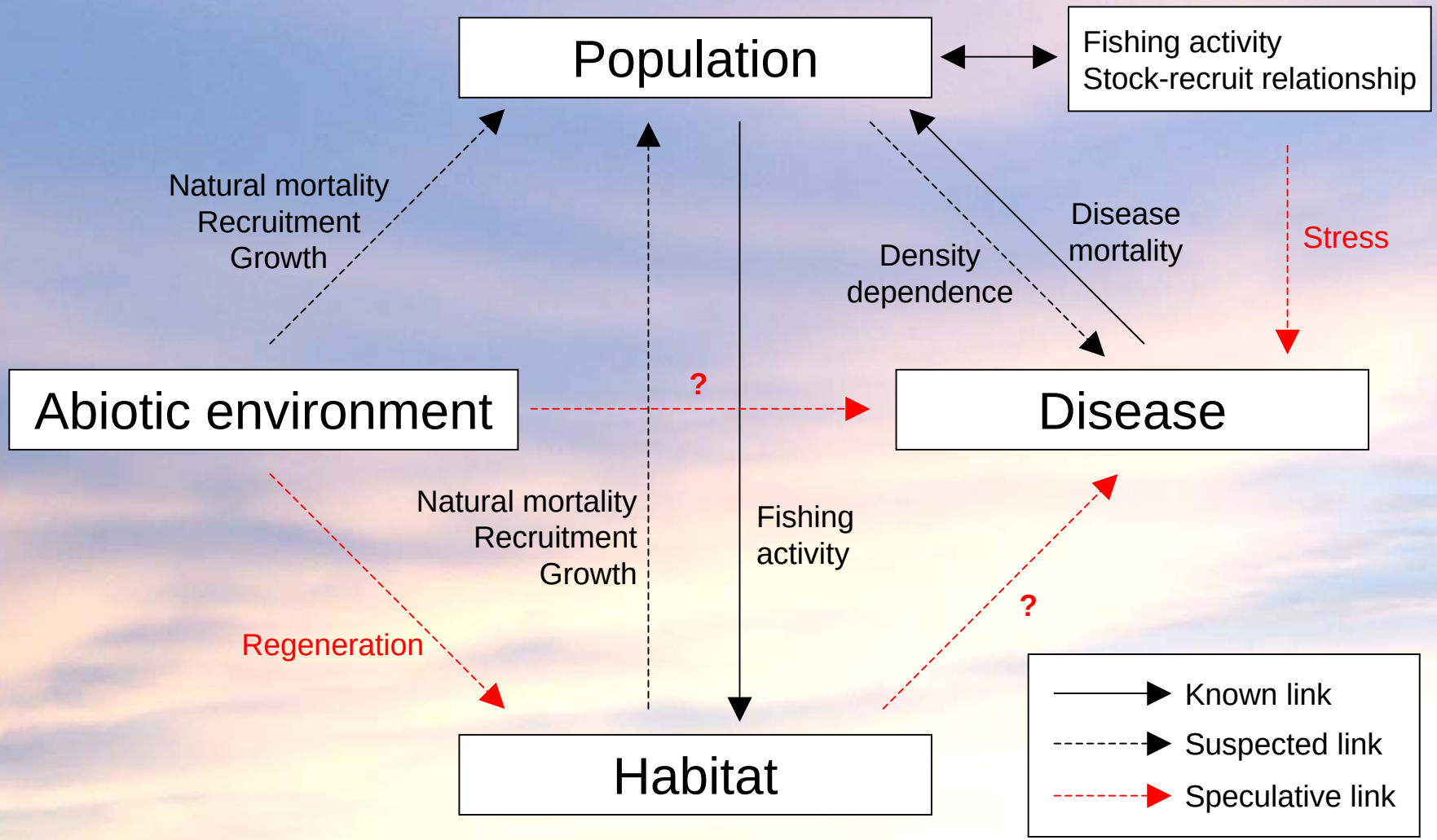
Critical relationships



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Critical ecosystem relationships

- Known ecosystem relationships:
  - Dredging changes benthic habitat, but it recovers “quickly”
  - On recovering habitat blue cod reach much higher densities, have a more diverse diet, faster juvenile growth and reduced mortality of 0+ fish
- Also know disease mortality major driver in oyster population dynamics, but links to fishing and habitat unknown

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Critical ecosystem relationships

- We do not know:
  - Changes in benthic habitat caused by dredging
  - Variation in patterns of regeneration, by location (spatial) and through time (temporal)
  - The role of different stages of benthic habitat regeneration in:
    - Oyster and blue cod production
    - In minimising oyster mortality from *B. exitiosa* infection
  - The role of environmental factors in oyster, blue cod, and benthic habitat production
  - Changes in prevalence and intensity of *B. exitiosa* infection from dredging induced stress compared to other environmental stressors

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FRST investigations

- Research to provide information for two key strategies:
  - To mitigate the effects of dredging
  - To remedy the effects of dredging

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FRST investigations

Question: How does dredging change benthic habitat and how does it regenerate?

Investigations:To describe the fish down and regeneration of benthic habitat using structured fishing:

- To investigate physical changes and changes to the species abundance and diversity
- To investigate spatial and temporal variation in regeneration
- To investigate the impact of dredging intensity and frequency on regeneration

Method: Structured fishing, logbooks, and direct benthic monitoring

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FRST investigations

Question: At what stage of benthic habitat regeneration is oyster production highest?

Investigation: To monitor oyster production on regenerating habitat

- To estimate settlement, survival, and growth of oysters to legal size
- To estimate the prevalence and intensity of infection by *B. exitiosa* and disease mortality
- To relate production to source oyster densities after dredging

Method: Monitor habitat and sample oysters

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FRST investigations

Question: What are the effects of habitat change on blue cod populations?

Investigation: To monitor blue cod production on regenerating habitat

- To determine what happens to blue cod after benthic habitat is fished
- To monitor the rebuilding of blue cod populations as the habitat rebuilds
- To describe the recruitment and survival of juvenile blue cod, and abundance of large blue cod on regenerating and dredged habitat

Method: Monitor densities and logbooks

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FRST investigations

Question: Can changes in fishing practise minimise changes to benthic habitat?

Investigation: Test new dredges and operational procedures to determine impacts on benthic habitat and their efficiency in catching oysters

- To determine the impacts of changes in operational procedures such as:
  - Tow length
  - Tow intensity
  - Tow frequency

Method: Experimental dredging, logbooks and monitoring

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FRST investigations

Question: Can fisheries data monitor oyster and blue cod production, disease mortality and stages of regeneration of benthic habitat?

Investigation: To index fishery data

- To identify bycatch species or clusters of species uniquely indicative of stages of benthic habitat regeneration
- To index recruited and pre-recruit oyster density from catch rates
- To index disease mortality from clock estimates

Method: Correlate and index data from direct sampling

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FRST investigations

Question: Can shell return increase oyster and blue cod production and accelerate habitat regeneration?

Investigation: To investigate shell return:

- To describe the regeneration of benthic fauna on shell reefs and compare to control areas
- To monitor the survival of spat returned on shell
- To estimate recruitment of oysters to shell reefs
- To estimate the recruitment and survival, and immigration of blue cod to shell reefs
- To monitor down stream settlement of benthic fauna

Method: Monitor habitat, oysters and blue cod

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FRST investigations

Question: Do shell reefs require brood stock oysters to maximise production (translocation) and to establish source populations?

Investigation: To investigate whether shell reefs with brood stock oysters have a higher oyster production than shell reefs without

Method: To monitor oyster settlement and recruitment to legal size

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Case study and other research

- FRST programme an integral component of case study
- Other research programmes funded by NIWA include:
  - Development of benthic camera systems
  - Defining fishery areas for spatial management
  - Research into the role of benthic fauna in minimising mortality from Bonamia

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Critical factors for success

- Collaborative approach
- Fishery scale experiments
- Data acquisition and logbook data
- Fleet control
- Structured fishing

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Tools and information for management

- Research used to develop management strategies and fishery data acquisition systems for a Fisheries Simulation model
- Fisheries Simulation model used to evaluate management options

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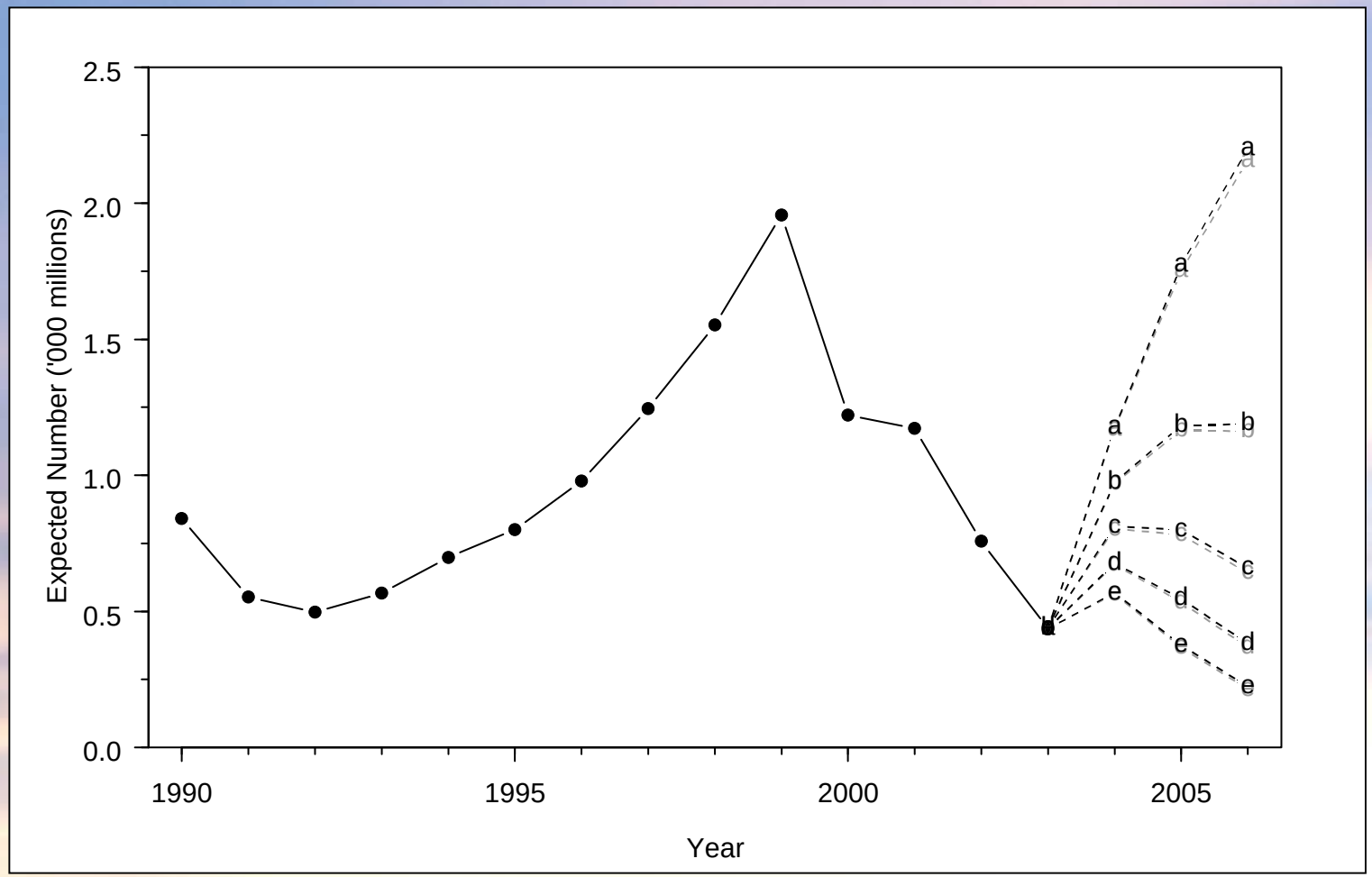
Projections



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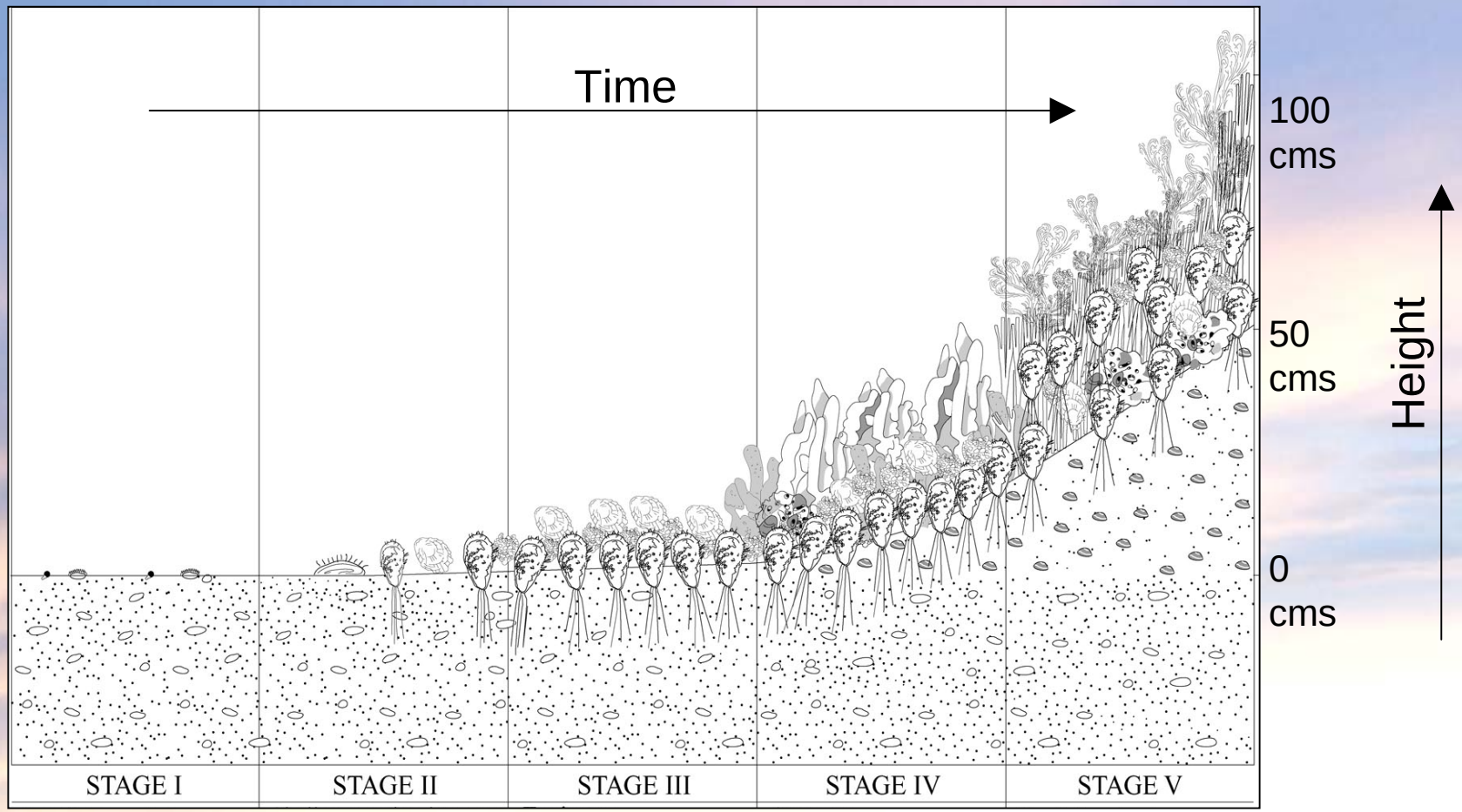
Regeneration of benthic habitat



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Evolution of research

1. Measure and record
   - Catch summaries/summary statistics
2. Develop indices and guidelines
   - CPUE indices
   - Abundance surveys
3. Investigate scenarios
   - CAY estimates
   - Disease mortality: Development of hypotheses
4. Make probabilistic predictions
   - Length based stock model
   - Epidemiological model
   - Spatially explicit coupled models
5. Forecast future events
   - Investigate alternative management strategies and predict results

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