Foveaux Strait Ecosystem Management Workshop

Invercargill
August 2004
Agenda

• Welcome and introductions
• NIWA presentation
• Review of proposed research
• Discussion
• Summary
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
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.
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
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
Historical overview of research

Year
1920 1940 1960 1980 2000

Catch ('000 000s)
0 25 50 75 100 125

CPUE (sacks/hour)
0 5 10 15 20

A
B
C

NIWA
Taikoro Nukarangi
Historical overview of research

Oysters

- Bonamia surveys 1986–95 and 2000–04
- Ecology 1950–99 (observations)
- Effects of fishing 1997–2004
Historical overview of research

<table>
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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
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*
Historical overview of research
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
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
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
- Mortality from Bonamia thought to be higher in large oysters reabsorbing ova
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
Historical overview of research

Effects of fishing:
• Incidental dredge mortality 1997
• Bycatch composition 1999
• Changes in habitat complexity and settlement 1999–2000
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
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 dependent, small oysters and spat killed in high density areas with high infection
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
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
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
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
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
Critical relationships

Population

- Natural mortality
- Recruitment
- Growth

Abiotic environment

Natural mortality
Recruitment
Growth

Regeneration

Abiotic environment

Disease

Fishing activity
Stock-recruit relationship

Density dependence

Disease mortality

Fishing activity

Stress

Habitat

Known link
Suspected link
Speculative link

NIWA
Teikoku Nukerangi
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
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
FRST investigations

• Research to provide information for two key strategies:
  – To mitigate the effects of dredging
  – To remedy the effects of dredging
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
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
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
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
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
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
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
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
Critical factors for success

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

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Regeneration of benthic habitat
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