Tuangi (cockle) restoration: Whangarei Harbour case study

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NIWA
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Background to project

- Active programme to improve health of Whangarei Harbour
- Input from Kaitiaki Roopu of Whangarei Harbour

- Memories of good shellfish populations in past….
- Possible to restore them?

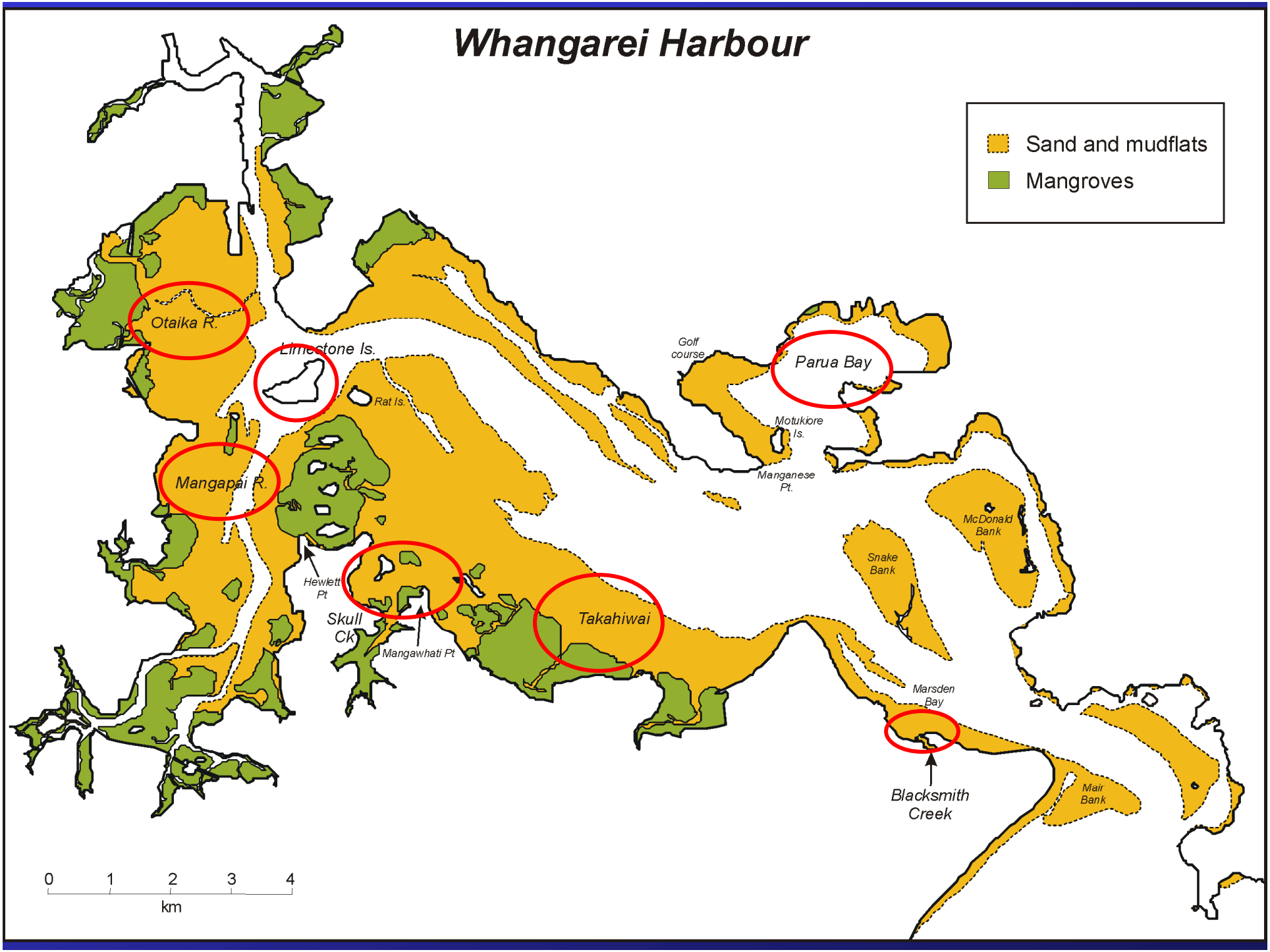
Roopu's goals

- "Bring the harbour alive"
- Combine traditional and scientific knowledge
- Create a model for other groups / harbours to pass on the knowledge gained
- Educate people about shellfish issues

NIWA's role

- provide scientific input and guidance

- use our knowledge to increase the projects chance of success

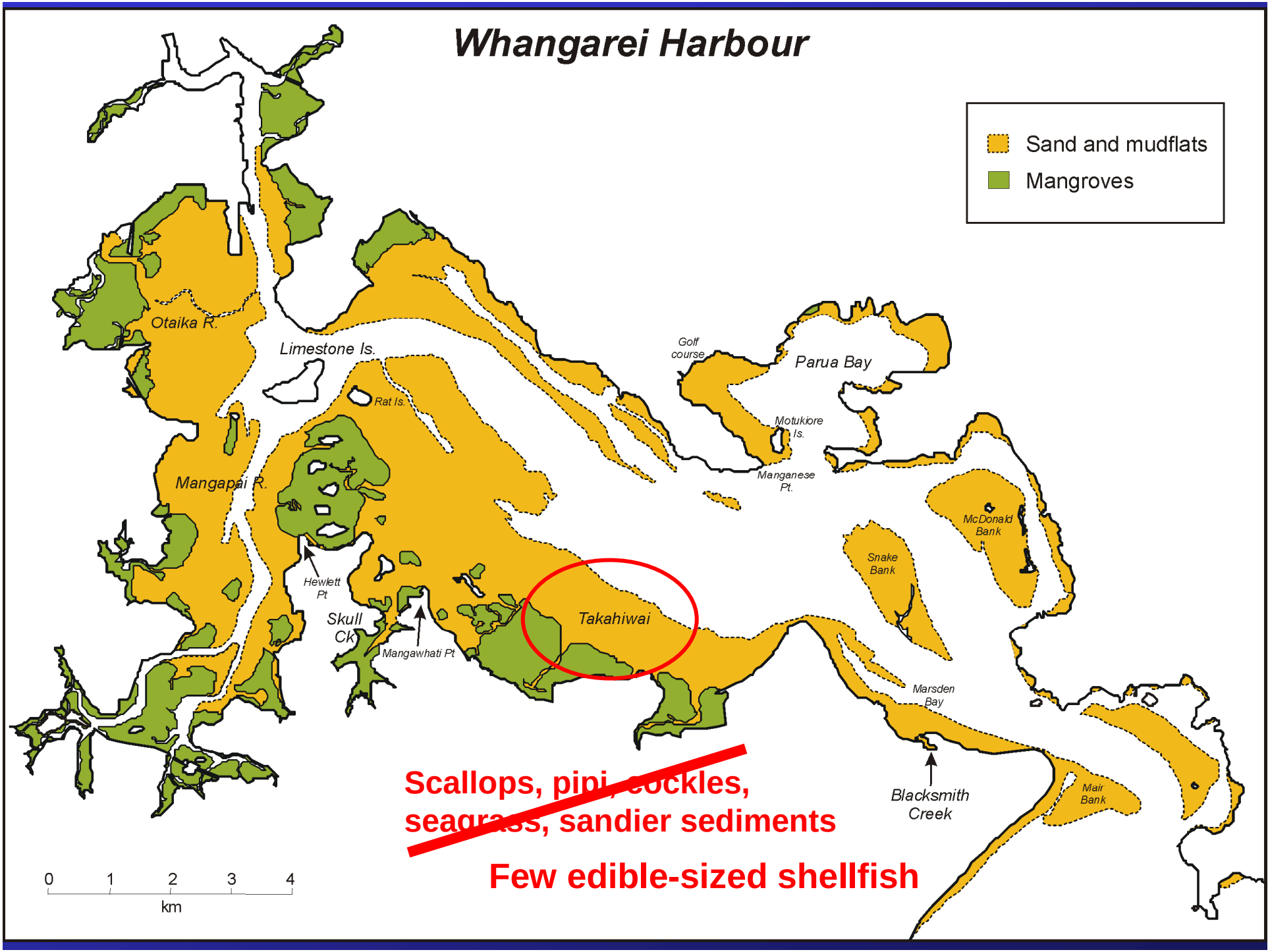

Whangarei Harbour
Sand and mudflats
Mangroves
Otaika R.
Limestone Is.
Rat Is.
Mangapai R.
Hewlett Pt
Skull Ck
Mangawhati Pt
Takahiwai
Golf course
Parua Bay
Motukiore Is.
Manganese Pt.
McDonald Bank
Snake Bank
Marsden Bay
Blacksmith Creek
Mair Bank
0 1 2 3 4
km

Suitability of these areas for shellfish reseeding?

- Discussions
- Review of existing information on intertidal communities, habitat types
- Site visits

Site visits

Habitat type (e.g., sediments, exposure)
Number, size, potential to grow to harvestable size (cockles >35 mm)
Predators
Other inputs (e.g., sedimentation, water quality)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Manganese Pt.
McDonald Bank
Snake Bank
Marsden Bay
Blacksmith Creek
Mair Bank
Scallops, pipi, cockles,
seagrass, sandier sediments
Few edible-sized shellfish
0 1 2 3 4
km

Consider…..

- Size to transplant?
- Mobility?
- Number / area to transplant?
- Predator protection?

Risks, long term commitment . . .

Common goals . . .

Start small, trial different methods

➡ ***Most successful reseeding methodology***

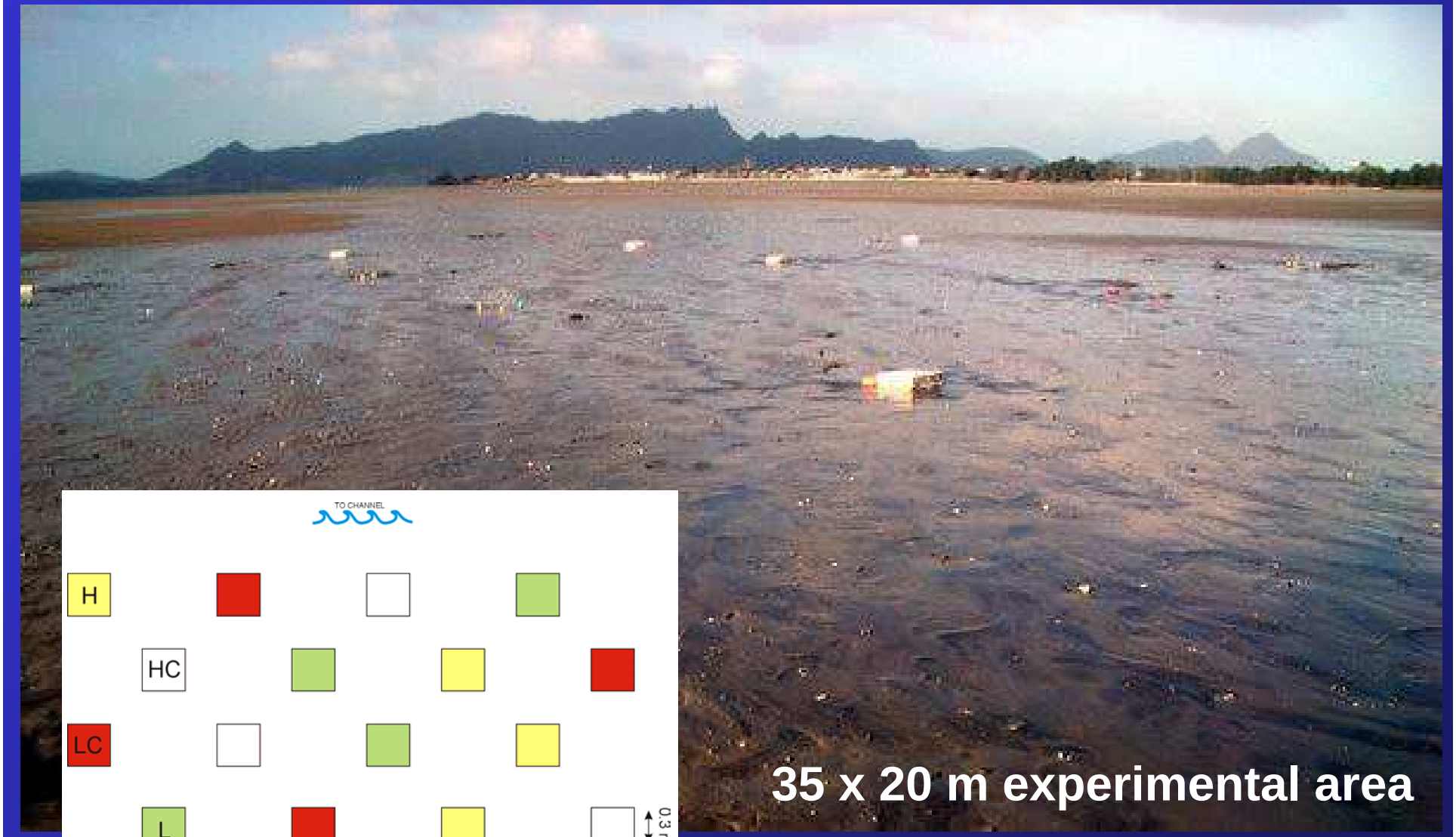
Tuangi reseeding trials

- 3 trials, each 1 year long
- transplanted adults (25-32 mm) from Snake Bank
- routine monitoring

Trial 1: Density and need for predator protection

- **0.3 x 0.3 m plots**
- **High / low densities, 75 / 20 individuals**
- **Uncaged / Caged** (4 mm mesh)
- **4 replicates**
- **Takahiwai East / West**
- **Established in July 2004**

Marked and measured all transplanted cockles



35 x 20 m experimental area

Trial 1: Monitoring

6 weekly for 12 months

cages cleaned weekly


Growth, survival, deaths,
sediments, predators


Growth, survival, deaths,
sediments, predators,
movement

Trial 1: Results

- **Recovery:**

  ~ 30% of cockles transplanted remained in the plots 12 mo later

  Abundances enhanced relative to pre-transplant densities

- **Growth & Sediment characteristics:**

  no effect of Density, Caging or Site

Trial 1: Results

- **Survival:**

  July 04 – March 05: high survival

  March 05 – May 05: more deaths….

  (i) at the East vs West site

  (ii) in high density caged plots at both sites

  More stressed in extreme weather conditions?

- **Dispersal from uncaged plots:**

  Biased random walk model, allowing for aggregation of conspecifics

Trial 1: Recommendations

- **No cages** (no predation; higher deaths)
- **West site** (higher survival in later months)
- **Transplant at intermediate densities** (40-50 per plot)
- **Larger plots** (faster restoration?)

Usefulness of monitoring

helped determine why higher deaths in last few months of monitoring cf. guessing what might have caused them….

Trial 2: Optimum plot size

Small (30 × 30 cm; 45 inds)
Medium (60 × 60 cm; 180 inds)
Large (90 x 90 cm; 405 inds)

} 500 individuals m^{-2}

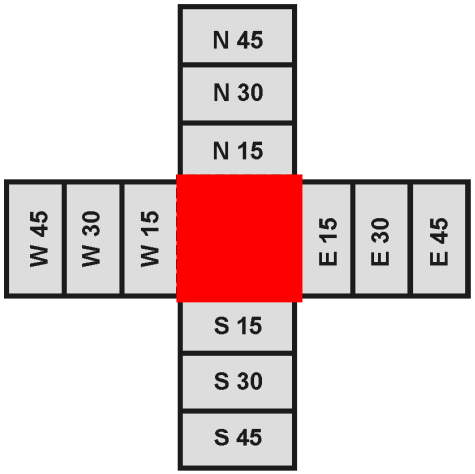
Takahiwai West site
4 replicates of each plot size
Set up November 2005

63 x 63 m experimental area

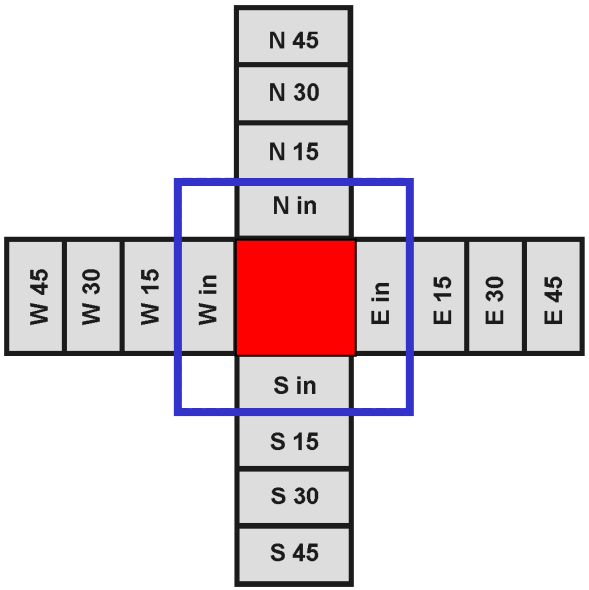
Trial 2: Monitoring

- growth and survival
- sediment characteristics
- **rates of movement of transplanted cockles**
- 2.5 month intervals (Feb, Apr, Jul, Sept, Dec 2006)

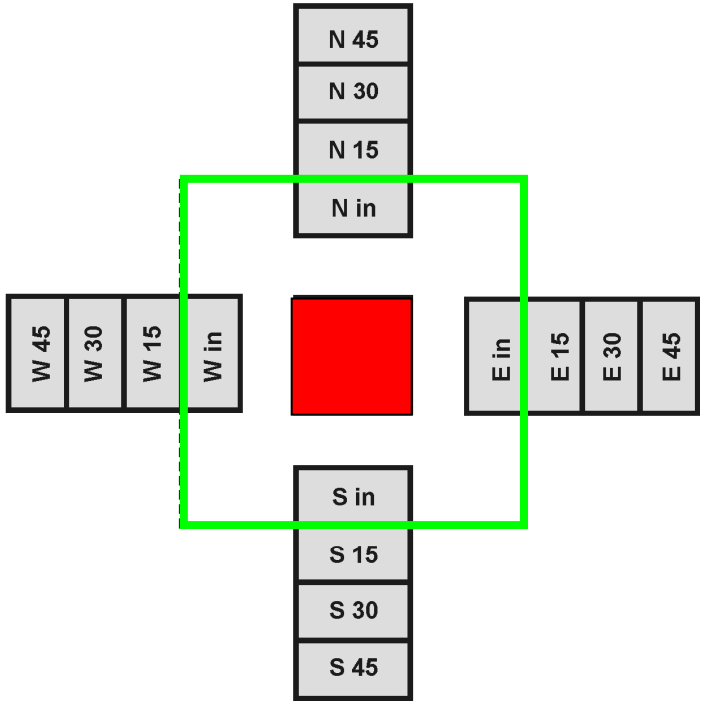
small



medium



large



Live/dead marked
Live unmarked

Live marked cockles in central 30 x 30 cm plot

- #’s declined over time; quickly in the Small plots
- Higher recovery/survival in Medium and Large plots
- Medium and Large transplants enhanced natural density in area by 2.3× and 1.4×

Trial 2: Results

Growth
Sediment characteristics
Cockle deaths (#'s and sizes)

} ***not affected by plot size***

Trial 2: Recommendations

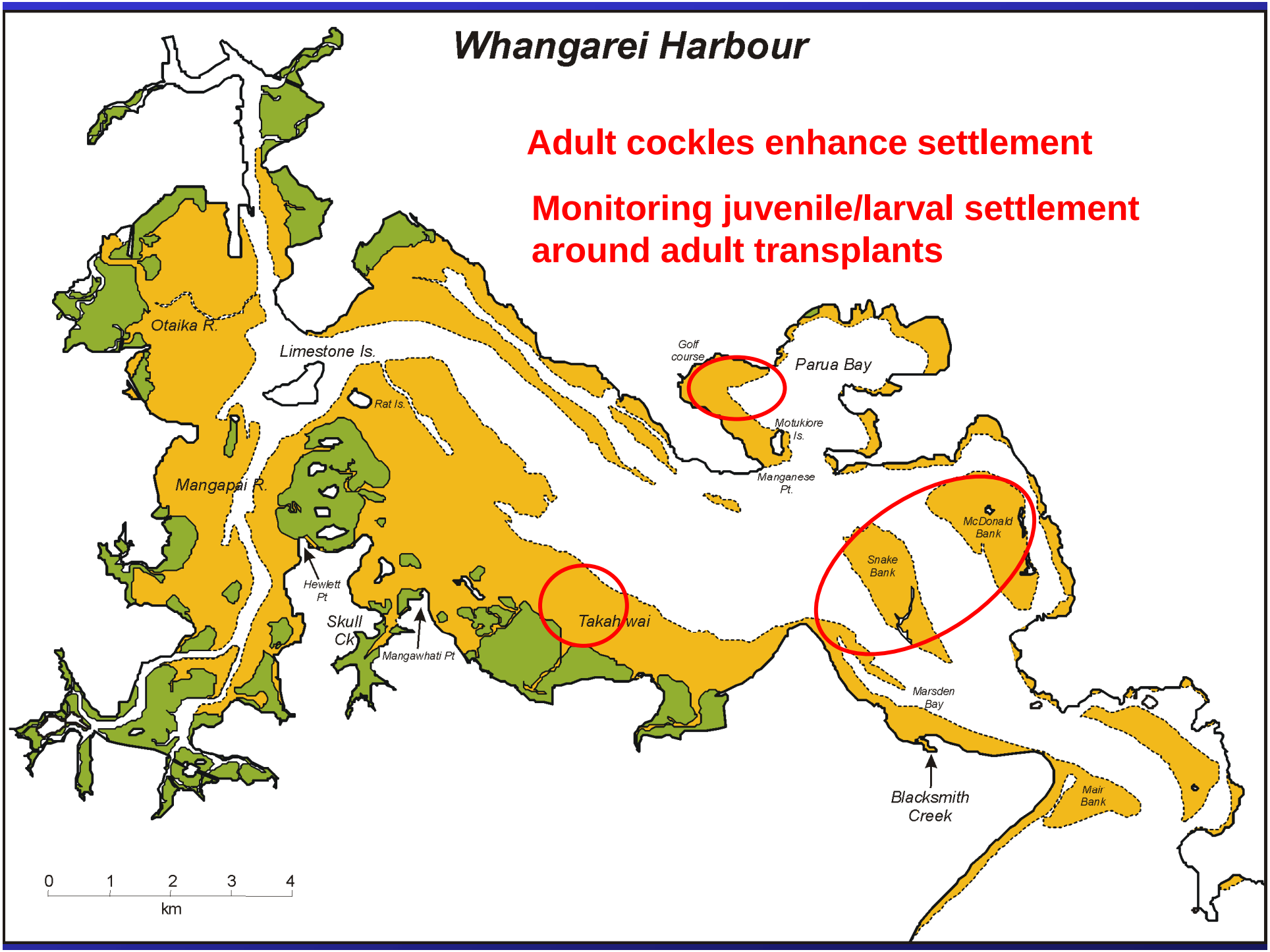
- **Medium or Large sized plots**
- **Medium more successful than Large plots?**

  (to be confirmed pending more analysis)

Trial 3: effect on recruitment plot arrangement

- **Takahiwai and Parua Bay**
- **‘Natural’ arrangement of cockles**

- **Established October 2006**
- **Monitoring targets recruitment**
  (Feb, Mar, Apr, May, Jul, Oct 2007)


Whangarei Harbour
Adult cockles enhance settlement
Monitoring juvenile/larval settlement around adult transplants
Otaika R.
Limestone Is.
Rat Is.
Mangapai R.
Golf course
Parua Bay
Motukiore Is.
Manganese Pt.
McDonald Bank
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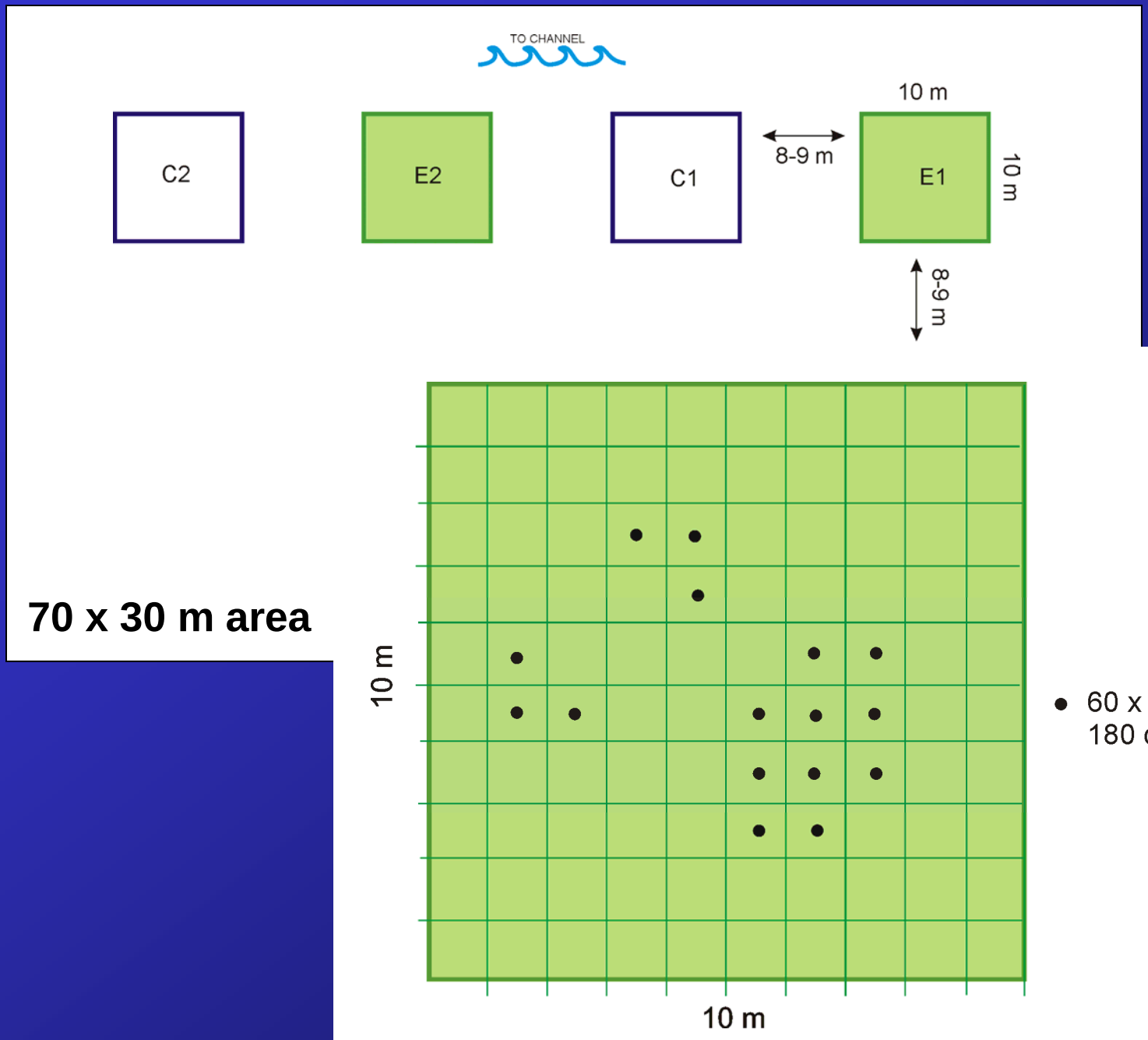
0 1 2 3 4
km


TO CHANNEL
C2
E2
C1
8-9 m
10 m
E1
10 m
8-9 m
70 x 30 m area
10 m
10 m
• 60 x 60 cm
180 cockles

What next?

Synthesis at end of Trial 3

On the Takahiwai sandflat:

- **Medium sized plots have higher success in terms of recovery**
- **Density equivalent of 500 m^{-2}**
- **Cages not needed for 25-32 mm cockles**

Recommendations for Whangarei, and other estuaries/community groups

Acknowledgements

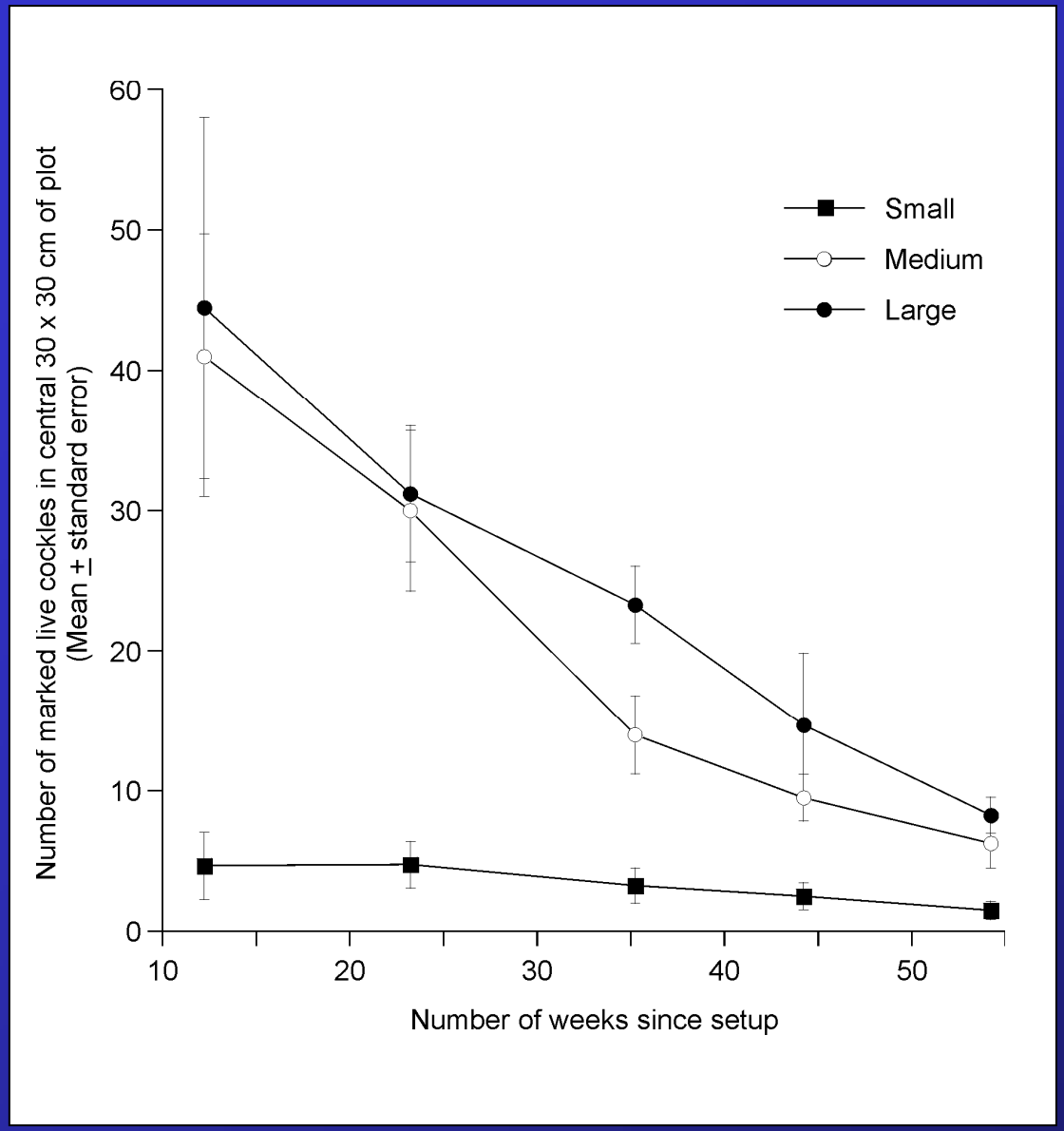
Kaitiaki roopu of Whangarei Harbour

NIWA staff (esp. Graeme MacKay & Jane Halliday)

Northland Regional Council's Whangarei Harbour Health Improvement Fund (Northport Ltd)

FRST Restoration of Aquatic Ecosystems programme CO1X0305

Live marked cockles in central 30 x 30 cm plot



- Would expect 45 cockles in central plot
- #'s declined over time; quickly in the Small plots
- Higher recovery/survival in Medium and Large plots
- Medium and Large transplants enhanced natural density in area by 2.3 and 1.4× cf. those in Nov 2005

- Around 30% of the adult Austrovenus transplanted remained in the plots 12 mo later, and abundances were enhanced relative to pre-transplant ambient densities.
- Austrovenus death rates increased in later months and were significantly higher for Austrovenus kept at high densities in cages. There was no effect of caging on plot sediment characteristics, no obvious targeting of the plots by predators and no size-dependency of the deaths. However, being caged at high densities appeared to act as a stressor that rendered Austrovenus less able to cope with extreme environmental conditions that occurred in these later months (stronger winds, higher mean temperatures, a larger temperature range and drought conditions).
- Growth rates were low over the 12 mo trial (<0.2 cm mo-1), did not differ significantly between sites, and were not affected by transplant density or the presence/absence of cages.
- In combination, these results indicate that uncaged plots are a better option for adult Austrovenus.
- Dispersal of Austrovenus from the uncaged plots did not follow a simple diffusion model; rather a biased random walk model allowing for aggregation of conspecifics was a more appropriate measure.
- Modelling suggests that abundances of Austrovenus transplanted to areas of low ambient density will initially decline as they disperse, but that over time higher density patches will develop as they switch to aggregative behaviour. We recommend transplanting 'clumps' of small patches at moderate densities rather than large patches at high densities, in order to better mimic the natural situation. This is also less likely to increase lethal and sublethal predation as the small patches will be below the detection threshold of many predators
- Despite the decrease in numbers noted over the year following the transplants, average abundances on the last monitoring occasion were still higher than the pre-transplant densities (Table 2), indicating the potential success of this approach to Austrovenus restoration.