Framework for restoration decision making

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Session structure

- Recap on key science messages
  - NZ Freshwater Sciences Workshop
  - Earlier today: Shallow lakes are complex but much valued systems
- Restoration framework suggestions
  - Lake Hakanoa conceptual model
- Initial discussion (more at end of day)
  - Shallow lake values
  - Obstacles to restoration
  - Innovations to make progress

Shallow lakes have high values

Intrinsic Values

- Native fisheries
  - Eels
  - Mussels
  - Inanga
  - Kokopu
- Native plants
  - Lake edge and submerged
  - Riparian wetlands/forests
- Native birds
- Aesthetics
  - Many naturally tea coloured

Utility Values

- Flood control
- Land drainage
- Water supply
- Recreation
  - Boating & Swimming
  - Fishing & game bird shooting
- Waste assimilation
  - Sewage & stormwater
  - Farm runoff
  - Mine wastewater

Stressors & shallow "lake flipping"

1. Degraded by multiple stressors
   - Nutrients (N & P) + sediment + exotic plants + exotic fish
2. Exist in alternative semi-stable states

   A. Vegetated bed & clear water

   B. No plants & low clarity
      - Many have "flipped" from A to B
      - Hard shift from B to A

Lake degradation & equity

- Private land owner wealth increase at public water owner expense
  - Degradation of public lake ecosystem services
  - What is equitable balance?

- Rural and urban water sensitive designs can reduce nutrient and sediment loads
  - Filter strips, nutrient budgets & management, livestock mgmt, treatment wetlands, effluent and stormwater treatment/diversion, land use change…

Lakebed sediments

- Store Phosphorus from past enrichment
  - Recycled within lake as “in-lake P load”
  - Often need to manage *after controls* on catchment inputs in place
- In-lake P controls
  - capping, bottom water oxygen control…
  - show promise in deeper Te Arawa lakes (e.g., Okaro)

Exotic plants

- Key stressors
  - Plant-beds prone to collapse
  - But often better than no plants
  - Best to prevent introduction
    - Boat access, weed containment areas new boat ramps…
    - Education to stop spread by people (e.g., aquarium releases)

Exotic coarse fish

- Promote flipping to turbid/no plants state 2
  - koi, catfish, goldfish, tench
    - Disturb sediments & up-root plants
  - perch (and juveniles of above species)
    - Eat zooplankton that graze algae
      - Increases blooms and reduces water clarity
  - rudd
    - eat native plants

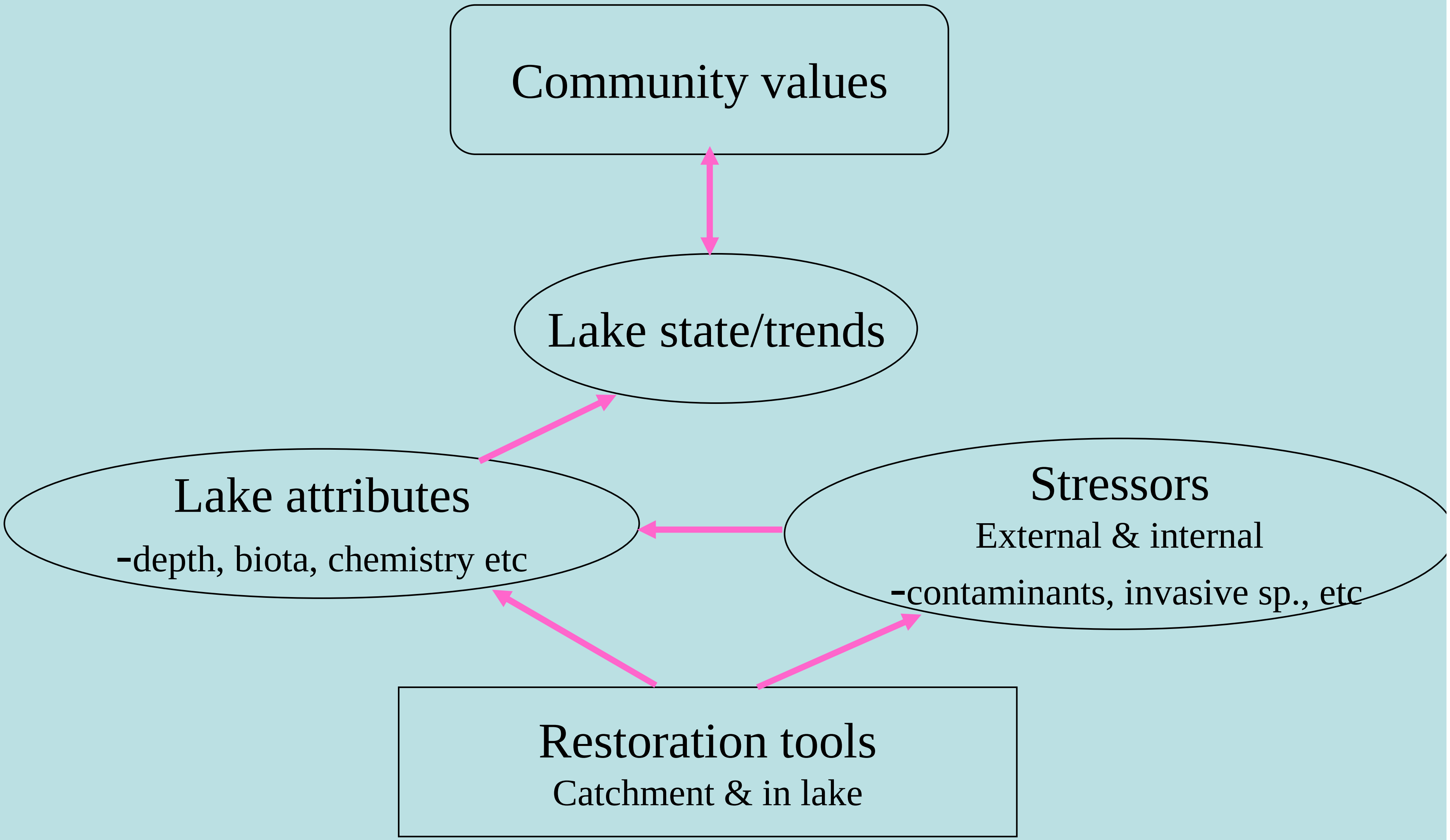
Conflicting community values?

- Coarse fishing VS clear water/plants
  - Designate coarse fish lakes?
  - Limit to 1 species/lake?
  - Ban coarse fishing?
- Yachting VS submerged exotic plants/clear water
- Clear water/no algal blooms VS intensive agriculture (without strong use of Water Sensitive Design tools)
  - Accord with farmers and urban authorities?
  - Tighter land use controls?
    - Nutrient cap and trade?

Much knowledge exists

- <u>But</u> shallow lakes understood less than deep
  - Models developed for deep lakes need adaptation to shallow lakes
- Lake restoration/rehabilitation
  - Complicated & complex
  - Synthesize catchment and lake knowledge
    - framework to support deliberation, consensus building and decisions
      - Case studies with monitoring
      - Fact sheets/ web site
      - Conceptual linkage models

Restoration Framework?



Key questions in lake restoration decision making

- What are the community values?
- Restoration goals?
  - e.g., aesthetic, recreational, biodiversity, water quality …
  - Are the public expectations achievable?
  - Are there contradictions in restoration goals?
    - e.g., Desire to have clear water but with no aquatic plants
- Current lake condition?
- What caused decline in lake condition?
- Nutrient status and nutrient and sediment loading?
- Constraints to effective management?
  - Economic, institutional, legislative, ecological

Restoration prioritisation factors 1. biophysical

- Lake size
  - Smaller systems are more amenable to restoration
- Lake depth
  - Deeper lakes are better candidates
  - Large, shallow lakes are very difficult to restore
- Wind fetch
  - A large wind fetch increases resuspension of bottom sediments
  - Small, deep lakes with a small wind fetch or wind breaks are better candidates for restoration
- Presence of exotic fish
  - Elimination necessary for most goals
    - If unacceptable/unachievable, then fewer species the better
    - Koi, rudd, catfish, tench and goldfish are particularly problematic
  - Likelihood of reintroduction must be considered
    - accidental and intentional

Key factors in lake selection
2. Human

- Catchment residents
  - Ideally a small number of landowners or a motivated care group
  - Preferably some Crown ownership or legal protection of land
  - Catchment residents willing to modify land practices to reduce nutrient inputs.
    - Studies suggest nutrient reductions of >50% are required
  - Catchment residents that are prepared to be involved in goal setting
- Regulations
  - Existing regulations providing some protection
- Sustainability
  - Existing partners with long-term commitment to the project
- Reliable funding sources

Key considerations in planning

- As a landowner or manager, seek information on the ecology of the site, area, and region
  - Scientists are eager to help
- Set clear achievable objectives that are appropriate to the site and its use
- Plan good science around the restoration to determine the effects of actions
- Consider whether it is possible to select an experimental lake for testing new actions on a small scale

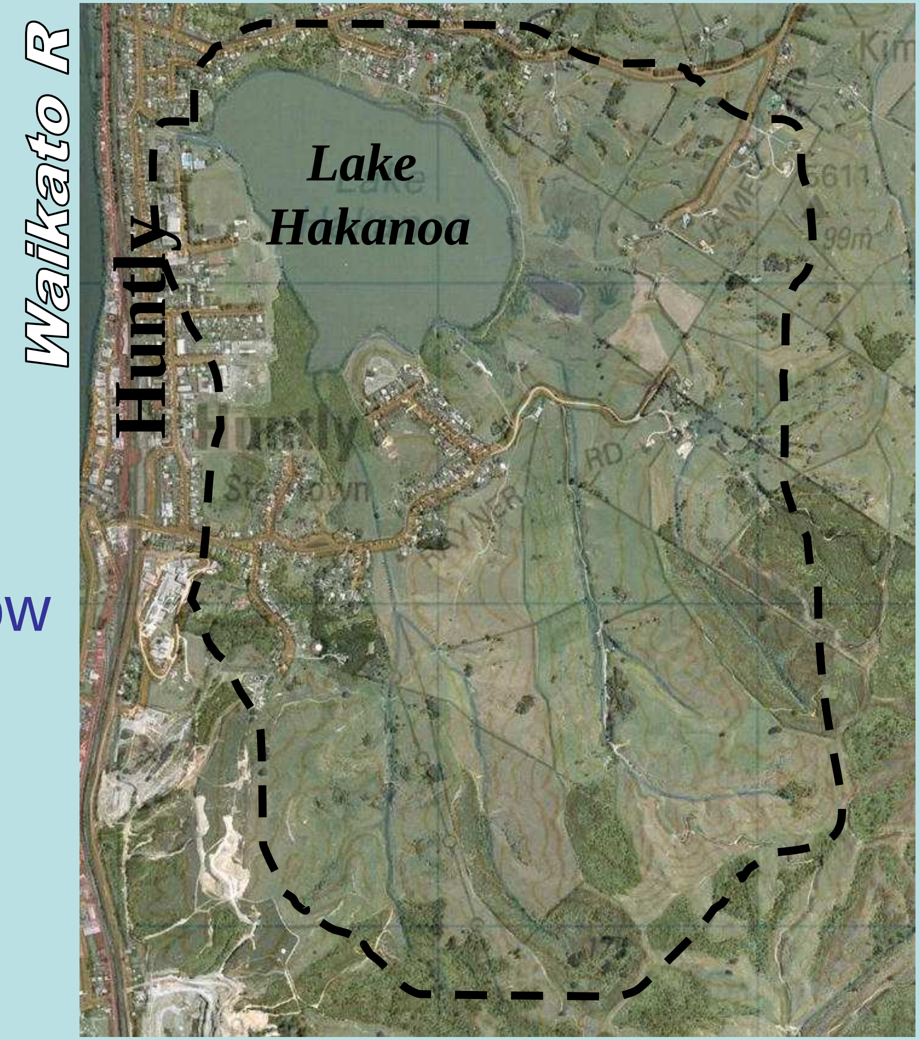
Lake Hakanoa conceptual model

- Case study
- WDC asked NIWA to help evaluate restoration actions

Hudson et al. 2008. Review of options for improving the condition of Lake Hakanoa NIWA client report HAM2008-067, 35 p.

Hakanoa Background

- Shallow (av. 1.65 m)
- Bed: soft, organic-rich silt
  - Wave-disturbed
- urban-fringe
- riverine lake (58 ha)
  - Waikato connects at high flow
- Remnant wetlands (S & E)
- Management:
  - DoC, Waikato DC & EW



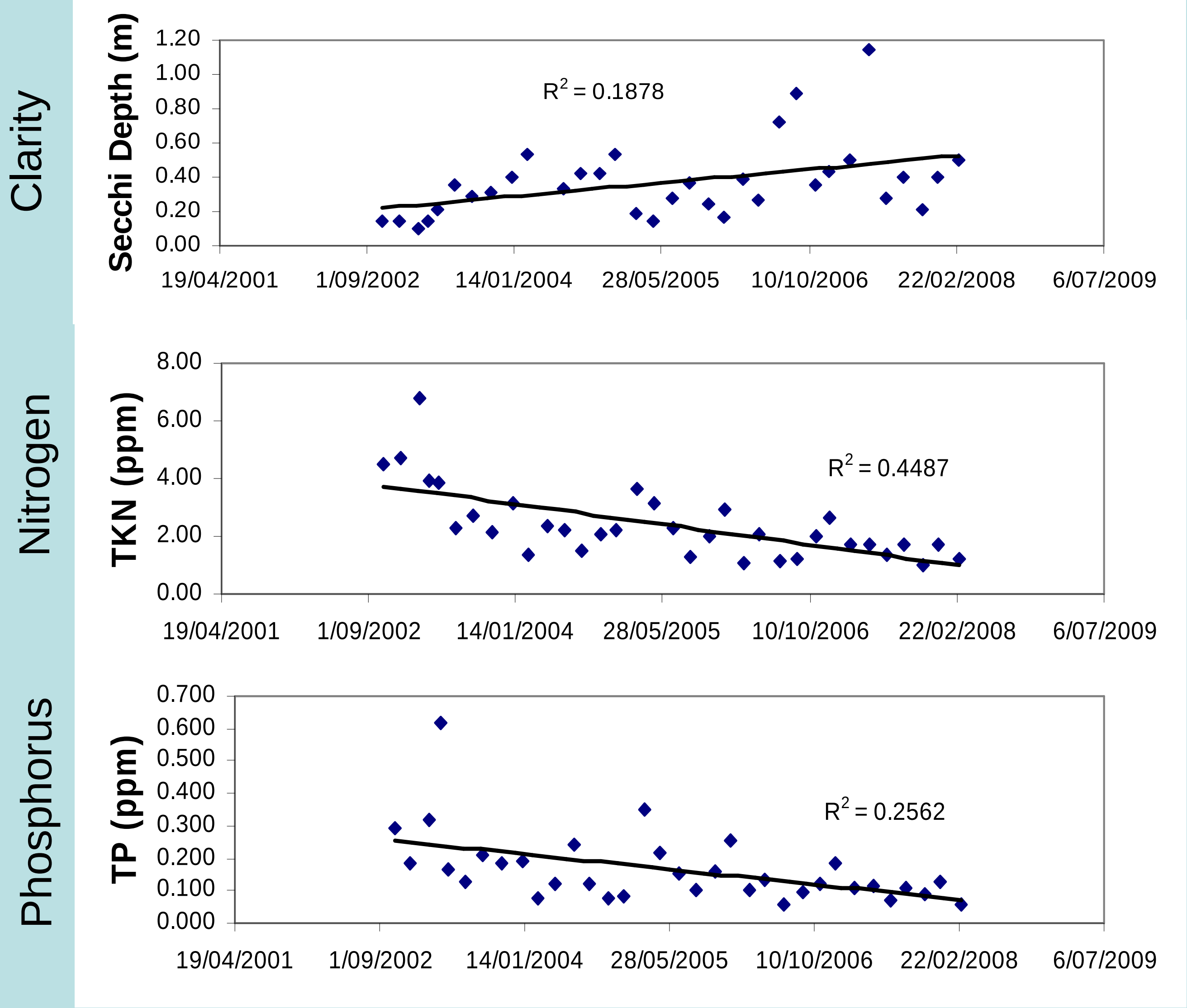
Hakanoa decline

- Pre-1970: Surface-reaching *Egeria*
- 1973 Plants declining
  - Herbicide weed control
  - Eutrophication
- 1983: clarity = 0.25 m, hyper-eutrophic, *BG* bloom
- 1988-1991:
  - No plants; clarity = 0.23 m
- 2003-05:
  - Cyanobacteria blooms *(Anabaena)* → Health warnings & odours
  - Occasional fish kills
- 2002-2008, positive trends

Koi carp

Vant & Pridmore 1981; Davies-Colley 1983;
Champion et al. 1993; EW 2003, 2005; EW unpub data

2002-08: improving WQ

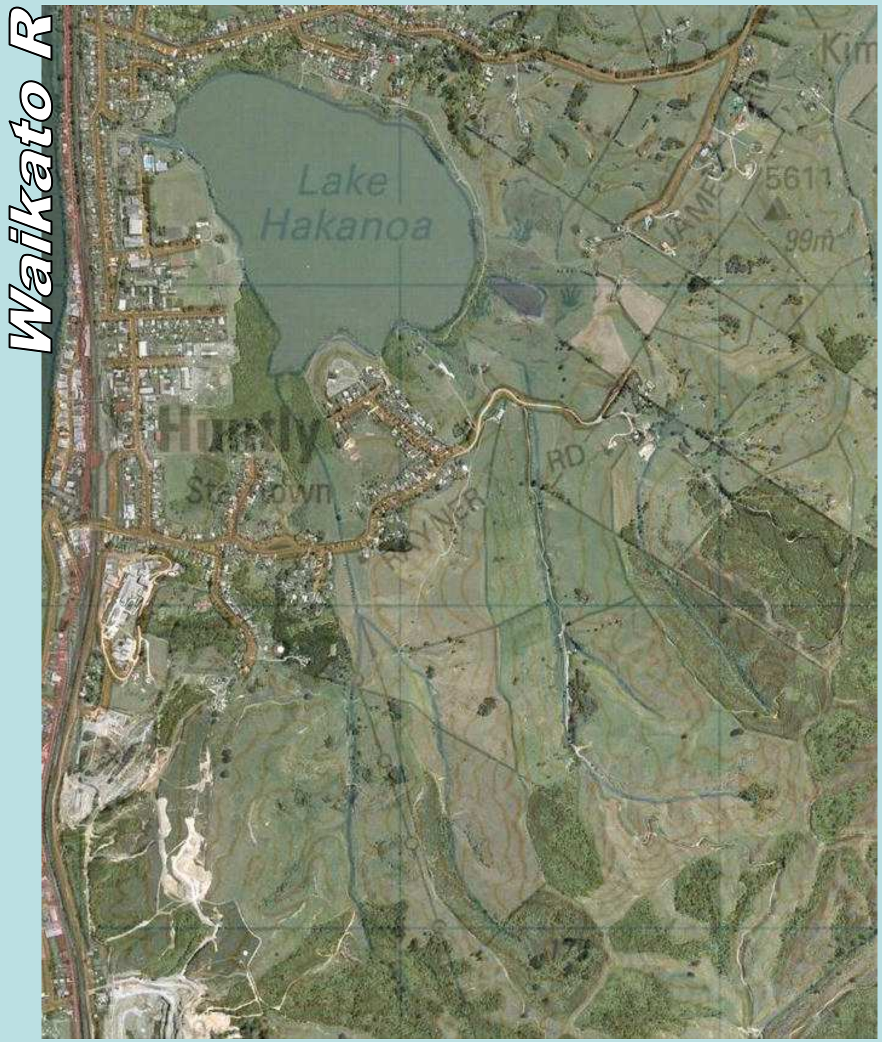


EW unpublished data

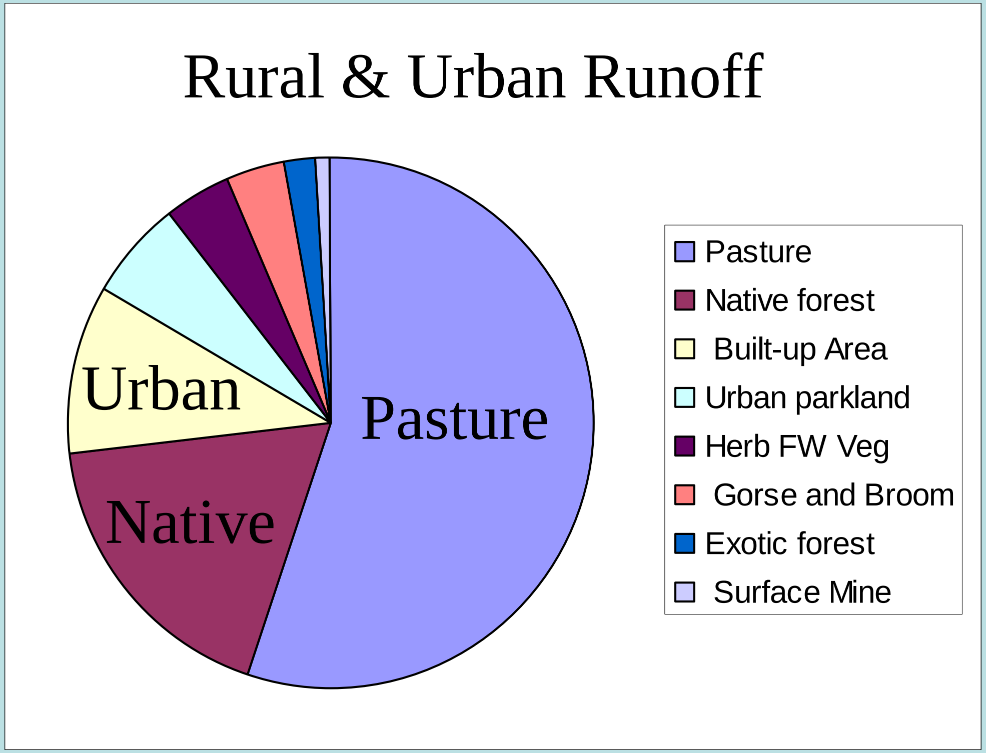
Hakanoa Community Values

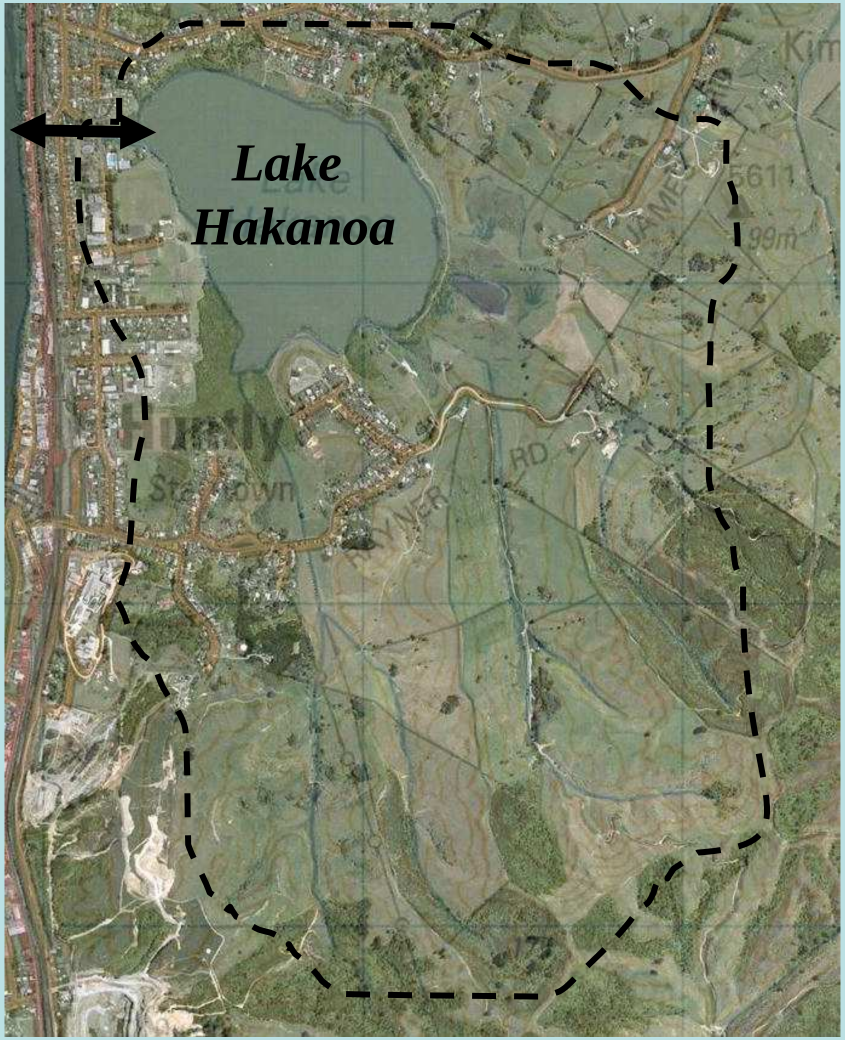
- **Values** (Waikato DC)
  - Recreation
    - Yachting
      - Open water
      - Clear water, blue hue
      - No blooms/odours
    - Walkway ($20K upgrade)
      - Aesthetics
    - Coarse fishing
  - Mahinga kai
  - Biodiversity

} Tainui & DOC



Hakanoa External Drivers





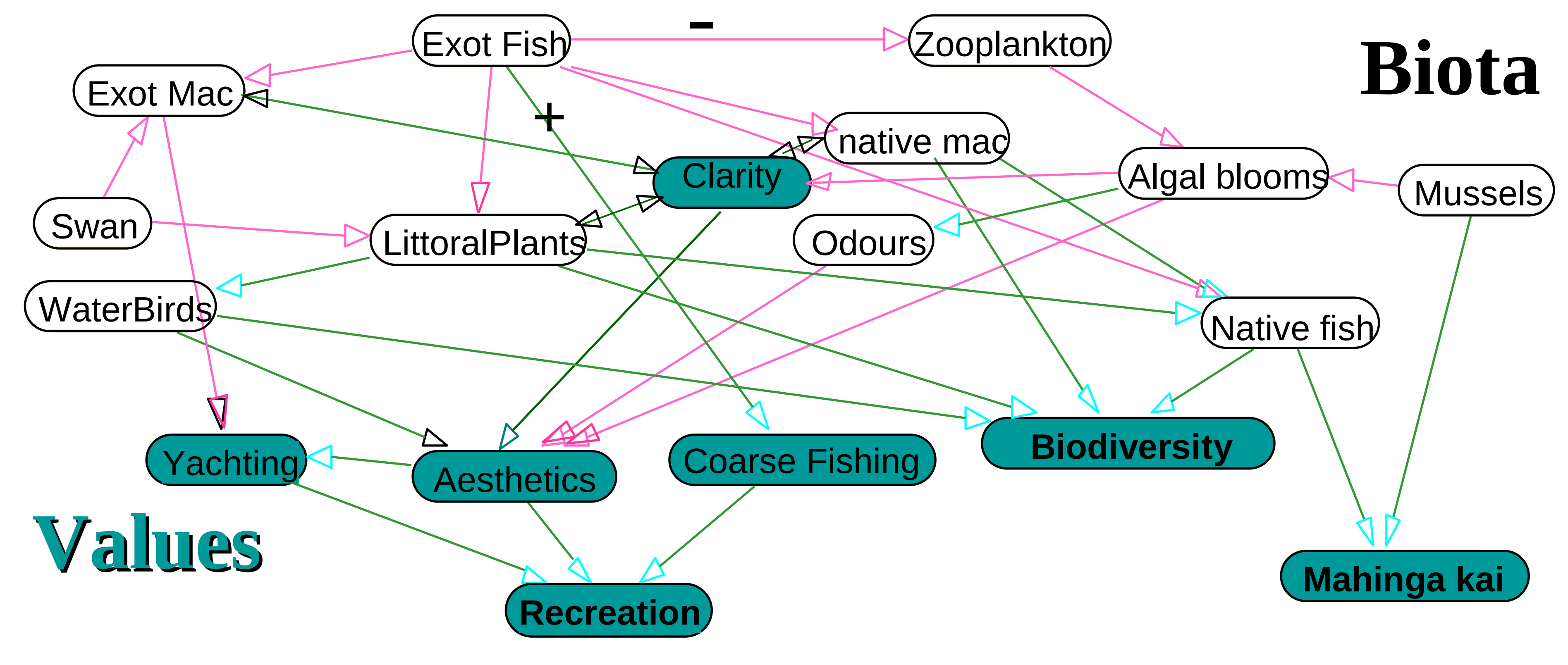
Exchange with Waikato R

- Flushing (+)
- Exotic fish & plant source (-)

Need linkage model

- Move beyond lists of values and stresses
- Causal linkage models
  - Graphic representation of systems
  - Mimic human logical thinking

Linkages: Biota to Values

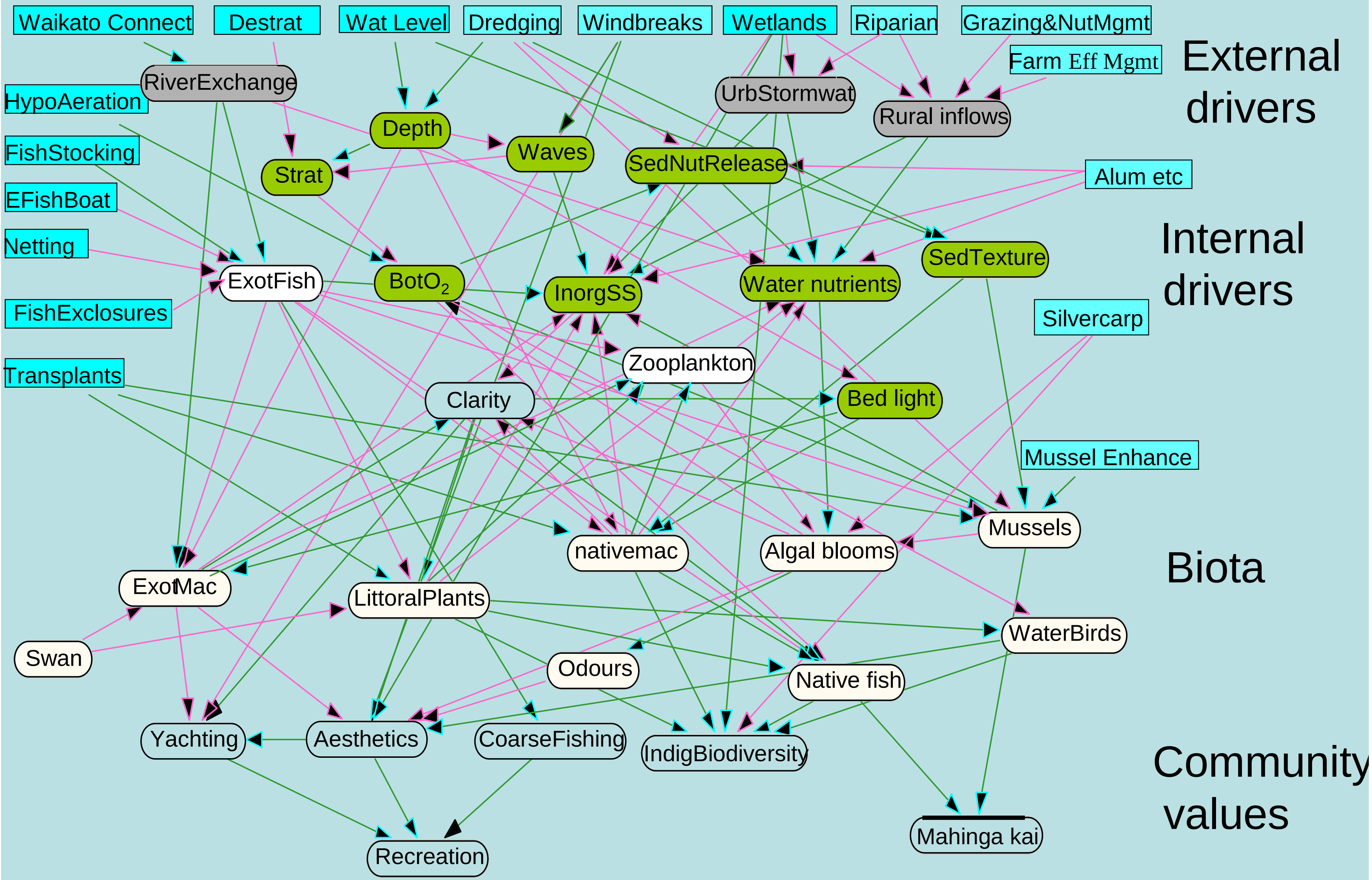


Value conflicts:

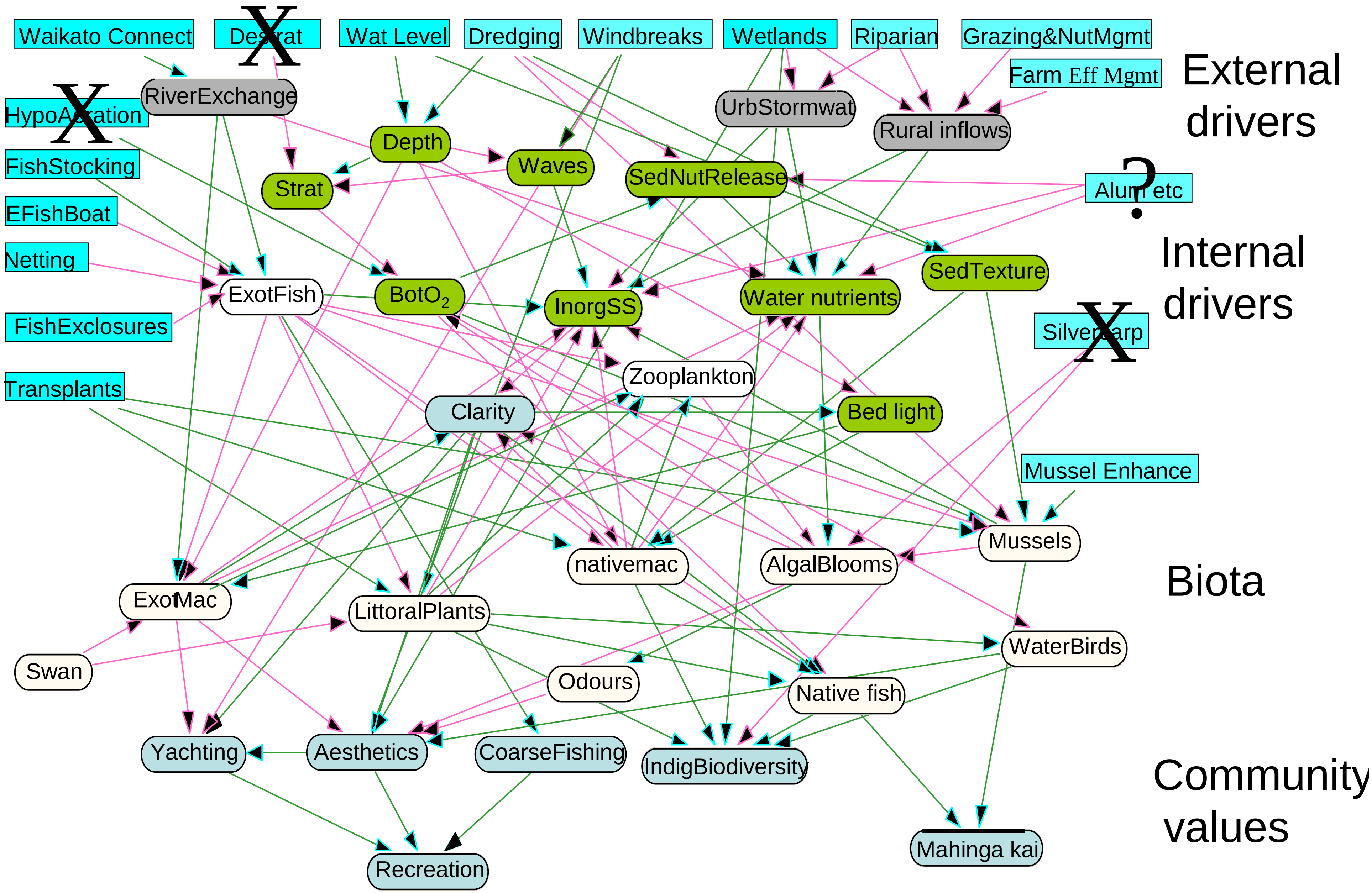
Coarse fish = good guys for anglers;

bad guys for biodiversity, mahinga kai and aesthetics

Hakanoa Rehabilitation Conceptual Model



Hakanoa – eliminated tools



Model implications

- Community's values conflict
  - Coarse fishing VS native biodiversity
  - Yachts, plants VS water clarity
    - More debate needed to set agreed goals
- Exotic coarse fish constrain options
  - Resuspend sediment and nutrients
  - Stop revegetation
  - Fish eradication unlikely?
    - River & angler reintroductions
    - Unlikely native plants will re-establish
- Slightly clearer lake with less blooms & restored riparian vegetation may be compromise goal?
  - Recent trends suggest this is attainable

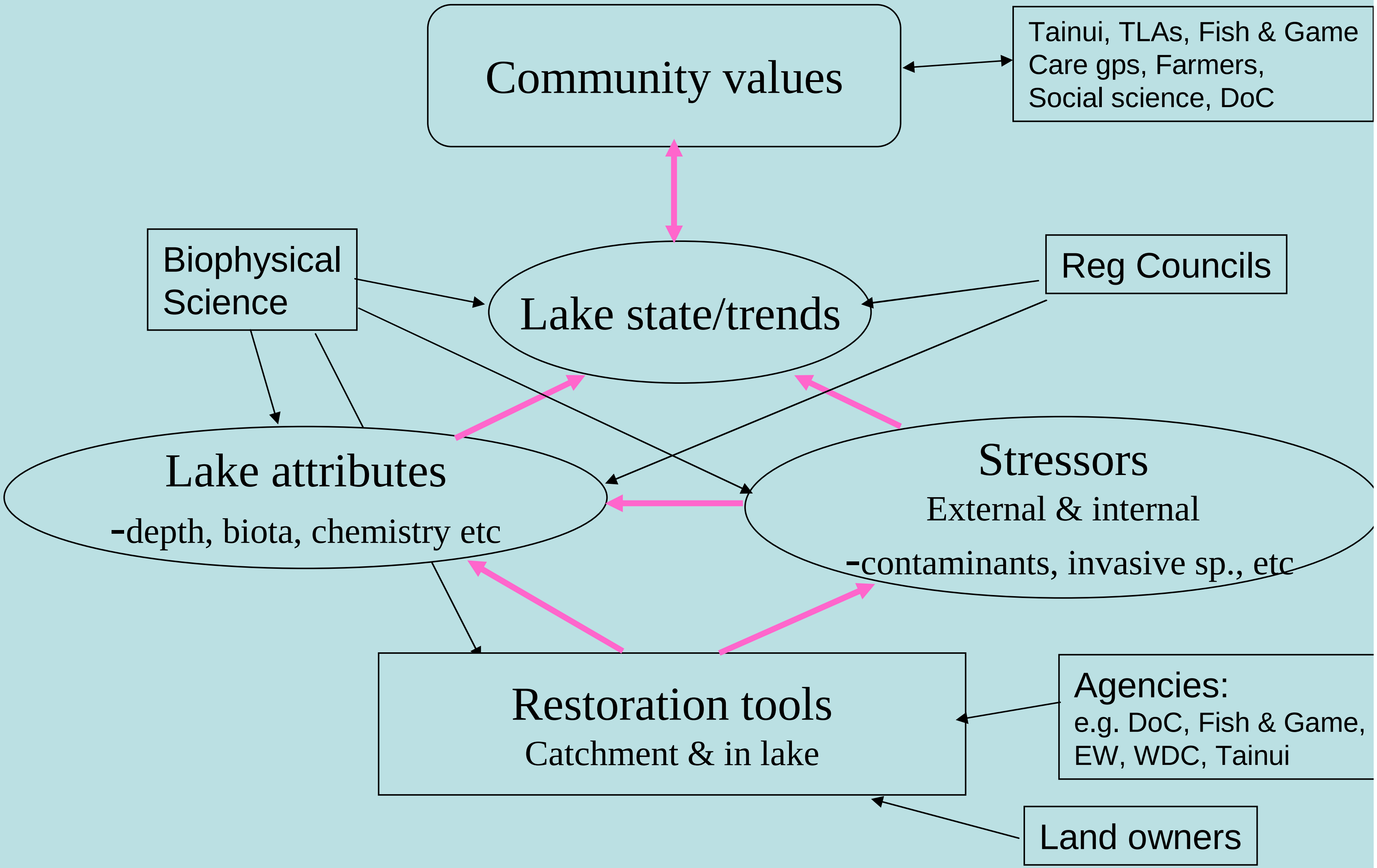
Conclusions Conceptual models

- Summarise
  - Existing knowledge
    - Better basis for actions
  - Ecosystem complexity
  - Value conflicts
  - Knowledge gaps

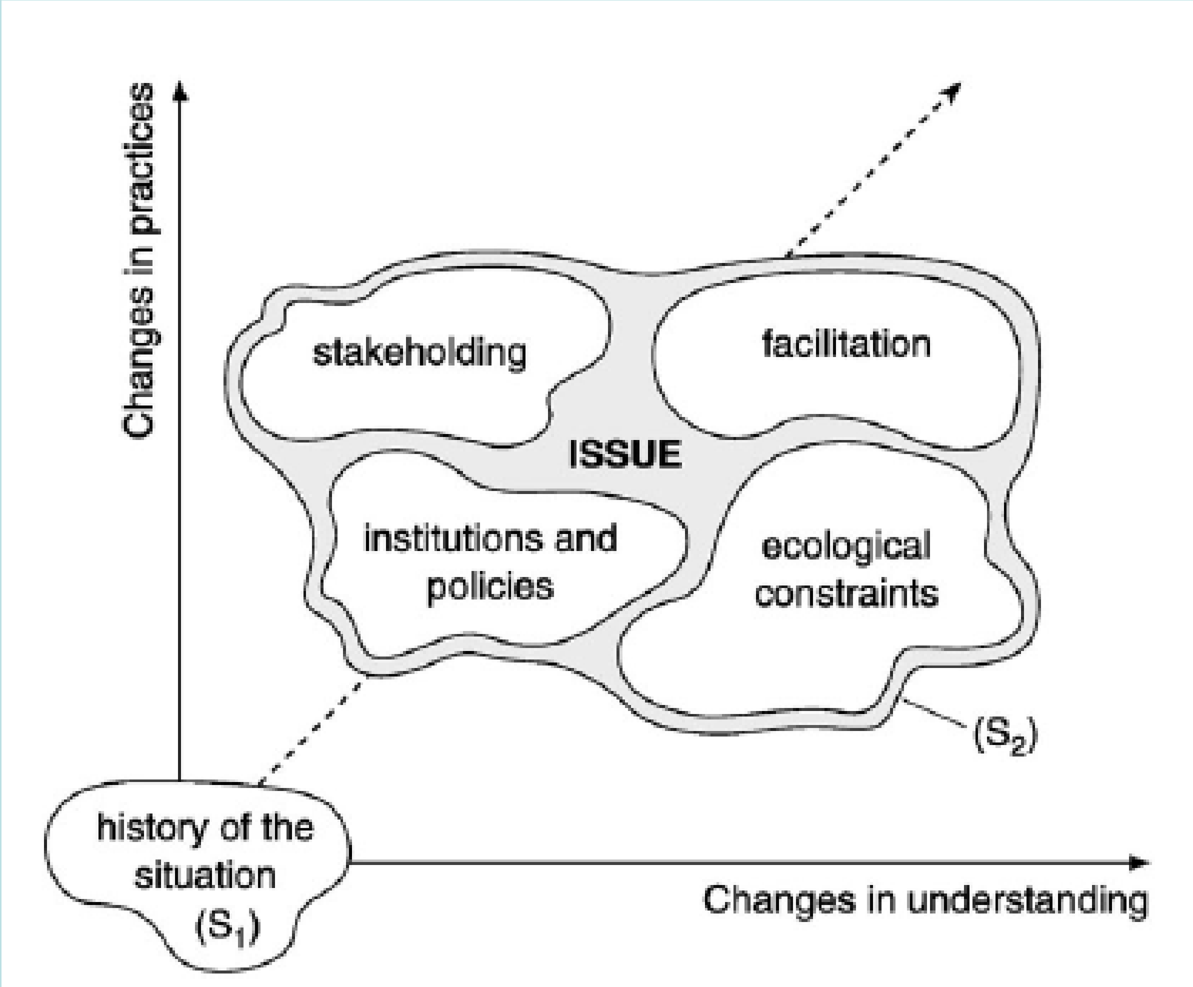
- Key building block for Restoration

- Generic models for lake types may provide useful restoration frameworks to be adapted
  - Shallow, deep, dune lakes, peat lakes, coastal lagoons etc
  - Some will be simpler
    - Dune lakes
      - No river connection
      - Less exotic fish/easier to control

Restoration Framework: Who does what?



Key elements for changing practice



SLIM = Social Learning for Integrated Management and sustainable use of water

Ison & Watson 2007: Ecology & Society 12 (1) 21

Questions to move forward

1. Agree on shallow lake values?
   - Variation between lake types/sizes?
2. Obstacles to restoration of these values?
   - Science & knowledge integration
   - Institutional
   - Legislation
   - Value conflicts
3. Overcoming obstacles?