An Ecological and Social Approach to Banggai Cardinalfish Conservation Management

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Banggai cardinalfish (BCF) *Pterapogon kauderni* (Koumans, 1933)

Need for Scientific Approach & Data
- To inform management & specifically MPA zonation
  - Biodiversity at all levels, including specifically BCF genetic population structure
  - Economic and social factors

National/Local Initiatives
- Banggai Cardinalfish Action Plan : multi-stakeholder, multi-year (2007-2012)
- Indonesian NPOA CTI-CFF (National Plan of Actions - Coral Triangle Initiative on Coral Reef, Fisheries and Food Security): Target 4, Action 3
- Banggai Cardinalfish Centre (BCFC)
- Banggai Kepulauan District MPA: Network of 10 Islands, 2 designated for BCF conservation - Pulau Banggai and Togong Lantang

Conservation Status:
- ENDANGERED - IUCN Red-List (2007)
- CITES Proposal 2007: withdrawn, Indonesia committed to conservation with sustainable use approach
  - National legislation: in process

Restricted Range Endemic Species:
- Paternal mouthbrooder with direct development: no pelagic phase
- High site fidelity & sedentary habit
- Relatively low fecundity
- Habitat (coastal waters < 5m depth) & micro-habitat (sea urchins, sea anemones, hard corals) threatened

Genetic Population Structure:
- Several studies
- 11 polymorphic microsatellites identified
- Known genetically distinct stocks separated by as little as 2-5km (discontinuous habitat, same island)
- Genetic distance between islands
- Local extinctions likely to mean total loss of entire genetic strains

Ornamental Fish:
- Traded since late 1980's
- High (600,000 to 1.4 million/year) volume relative to estimated total population (2.4 million)
- Long & complex trade routes & high mortality
- International concern (CITES proposal in 2007, articles, anti-wild-caught BCF campaigns)

INTRODUCTION

Indonesia: Coral Triangle country, signatory to the Convention on Biological Diversity (CBD)

Aquatic conservation increasingly concerned with intra-species genetic diversity[5]

- Genetically distinct fish stocks should be treated as separate management units[17,18], including in Marine Protected Areas (MPA)/ MPA network management[16]
- Genetic (DNA) analysis technology enables the identification of such units/stocks[6]

Goals:

1. To develop an approach to identify and incorporate BCF genetic units/ stocks into MPA zonation
2. To evaluate the District MPA potential for conserving *P. kauderni* populations and genetic diversity

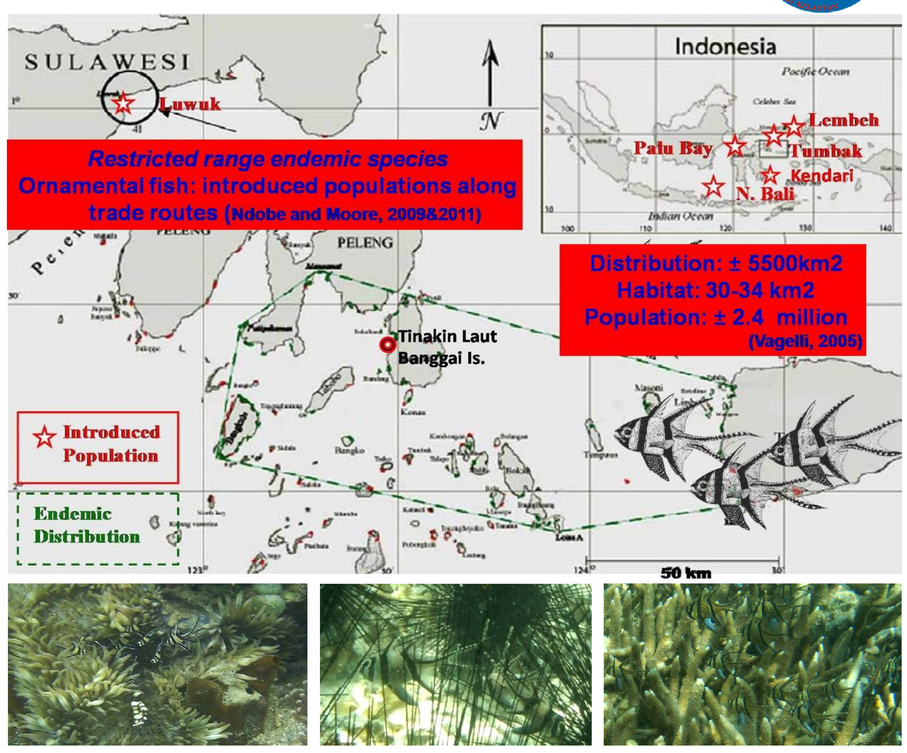
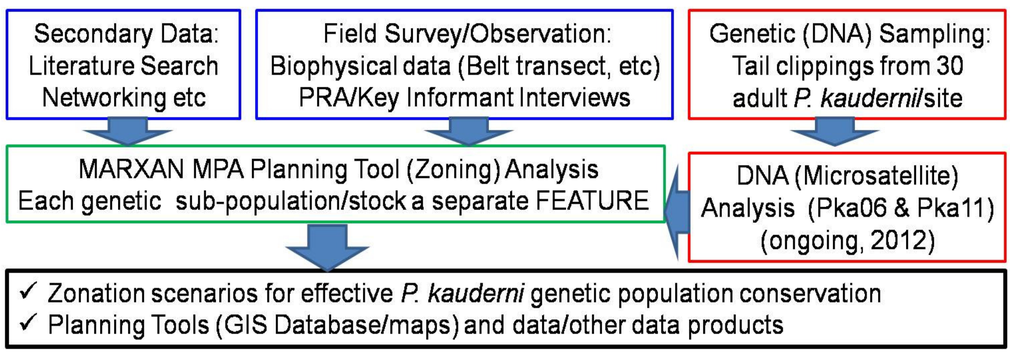


Figure 1: P. kauderni distribution (above) and key microhabitat (sea anemones, Diadema sea urchins, hard coral) within the shallow-water habitat: coral reefs, reef flats and seagrass beds under 5 m depth (below)

METHODS/APPROACH

1. Genetic stock zoning: use of MARXAN
   - Powerful spatial analysis tool for MPA planning[11];
   - can incorporate fisheries concerns[9]
   - zonation scenarios to achieve user-driven targets for the conservation of specific FEATURES at least COST.
2. Comparison between known BCF genetic diversity & MPA spatial coverage/targets



RESULTS AND DISCUSSION

Pterapogon kauderni Distribution & Genetic Population Structure (Fig. 2&3)

1. Togong Lantang: no *P. kauderni* population (Fig. 3): probable misidentification of *Sphaeramia nemtoptera*

2. Eastwards limits of *P. kauderni* distribution around Banggai Island and suspected stock boundaries

3. Agreement between data on the genetic composition of introduced populations[8] with social survey data on trade routes and releases[15] highlights the importance of relating socio-economic and biological data

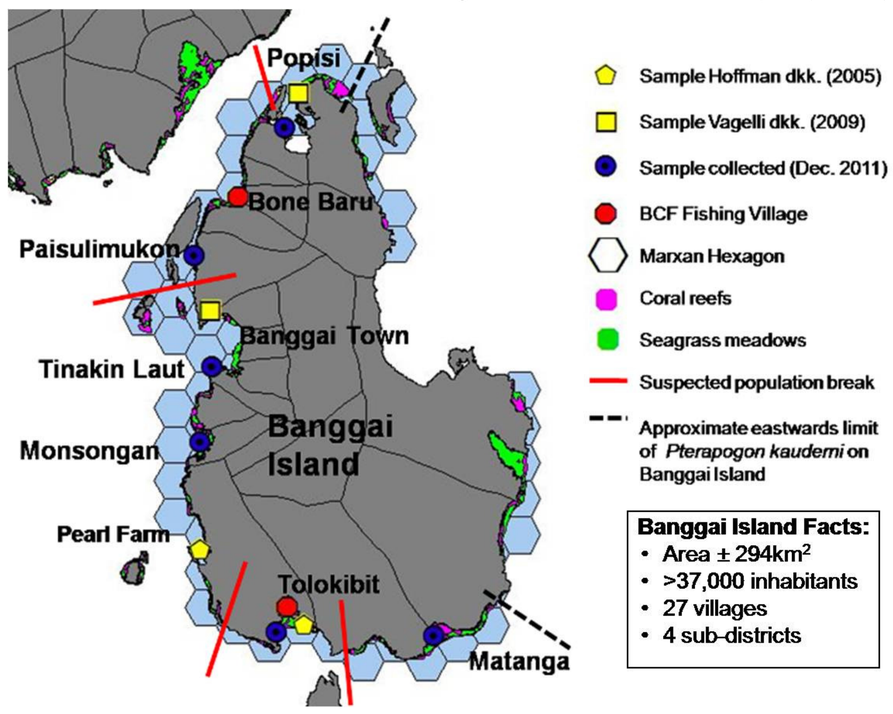


Figure 2. December 2011 Sampling Sites around Banggai Island (MARXAN planning units 2km diameter, based on the smallest distance between known genetically distinct BCF stocks; suspected population breaks based on environmental parameters and local knowledge

MPA Effectiveness for *P. kauderni* population/genetic conservation (Fig. 3)

1.The vast majority of the known *P. kauderni* distribution is outside the MPA boundaries
- of 17 genetic stocks[21] shown in Fig. 3, 15 are outside the boundaries of the MPA

2. Banggai Island is the only island with a BCF population AND BCF conservation as a target
- 4[8,21] or more genetically distinct BCF populations/stocks - genetic analysis in progress
- Major BCF fishing ground, complex administrative situation, many potential spatial conflicts of interest

Biophysical and Socio-economic Data

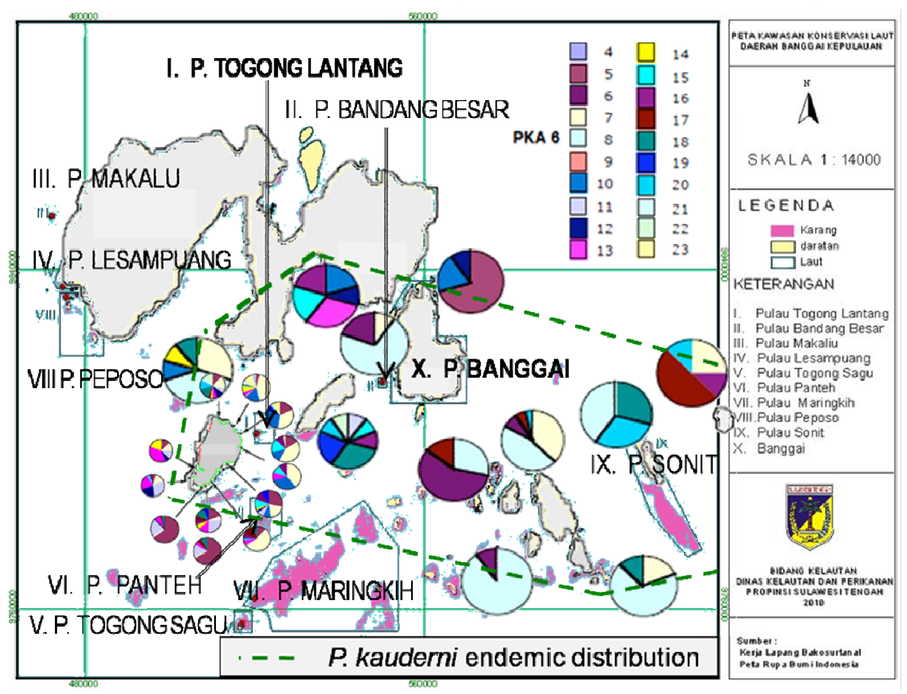
1. Substantial decline in Diadema sea urchins and sea anemones
- Apparent reasons: increased human consumption (both); use as feed for carnivorous fish grow-out (urchins)
- *P. kauderni* population decline noticeable wherever micro-habitat had declined (in/outside BCF fishing grounds)

To conserve the Banggai cardinalfish as a species, the difficult issues associated with habitat & micro-habitat degradation and loss must be addressed

2. Bone Baru community MPA - "LOCK-IN" for MARXAN planning
- ornamental fishers in Bone Baru (a major BCF fishing village, Fig 2) actively support BCF conservation
- no genetic FEATURE value as fish from many stocks/populations have been released there

Conservation of within-species genetic diversity - New Use for the MARXAN MPA planning tool

1. Initial runs: zoning options based on available data as a basis for discussion/consultation processes
2. Stakeholder inputs: predict the effects of specific choices on conservation targets (e.g. conservation of BCF genetic diversity) and/or costs and benefits associated with changes in conservation targets
3. GIS/Database use for monitoring/adaptive management - periodical data updates/additions



Note: Bold type designates the 2 islands designated for P. kauderni conservation

Figure 3. Overlay of the District MPA 10 island network with the known P. kauderni endemic distribution and some genetic population data[21]. ***MPA Area I (Togong Lantang) designated for BCF protection has no BCF population*** *(survey December 2011); Areas II, VI and IX have BCF populations but these are not designated as conservation targets; Areas III, IV, V, VII and VIII are outside the known BCF endemic distribution area*

LIMITATIONS AND OPPORTUNITIES

1. **Poor match between MPA coverage/targets and BCF distribution/genetic diversity**
2. **Potential Contribution to Species Conservation:** BCF conservation around Banggai Island based on genetically determined units would protect several (4 or more) distinct genetic stocks
3. **Potential Contribution to Coral Triangle Conservation Goals:** the proposed approach should provide a valuable tool for adaptive management/conservation planning within the Banggai Kepulauan District MPA, making a significant contribution to NPOA CTI-CFF goals through the conservation of BCF habitat/microhabitat, populations and genetic diversity
4. **Opportunities for Expansion:** (i) other islands with *BCF* populations within the MPA; (ii) the designation of further areas for BCF conservation, e.g. community MPAs or under the proposed designation of the Banggai cardinalfish as a species with limited protection

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