Coastal & marine conservation projects

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Projects

- Understanding shore angling
  - EfD project, commenced 2012
- Impacts of MPAs on fisheries and coastal fisher communities
  - EfD Collaborative project, commenced 2012

Angling paper 1. Factors determining the spatial distribution of shore anglers

J Turpie & J Goss

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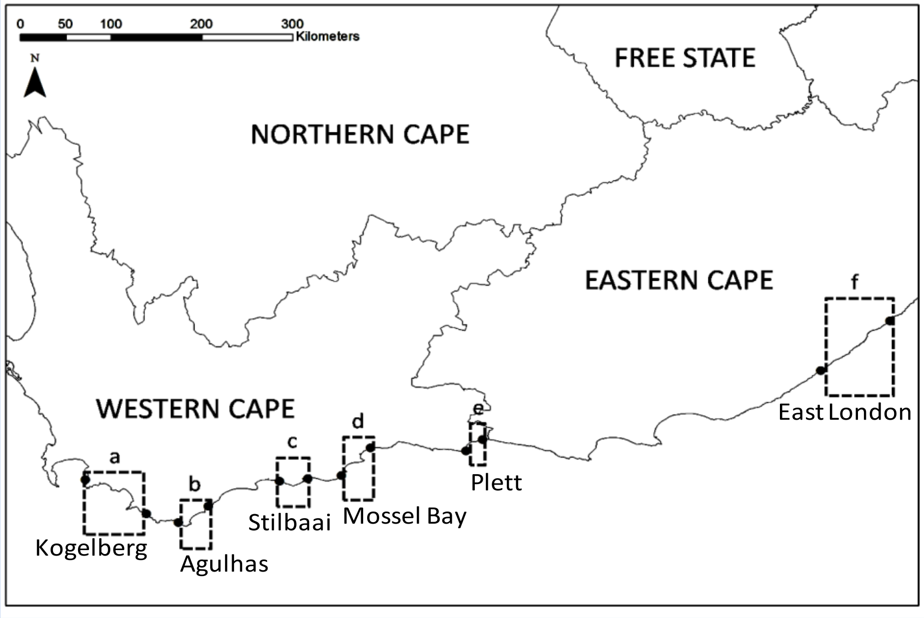
Aim

- Develop an understanding of the drivers of spatial distribution of shore-angling pressure around the coast, so as to inform strategies for the recovery and sustainable management of threatened fishery resources

Study area

- Six locations along the south coast of South Africa, within the Eastern and Western Cape Province



Data

- Roving creel surveys – Jan 2010 to Aug 2011
- 6 areas divided into beats (~8km), monitored randomly, recording position, effort and catch of anglers.
- These were further divided into sub-beats on the basis of habitat
- Each survey of each sub-beat was treated as an independent observation.
- 9525 angler records collected, 8797 of these could be definitively placed in a sub-beat.

Location	Total length (km)	# of beats	# of sub-beats
East London	109.2km	20	124
Kogelberg	140.3km	18	62
Mosselbaai	66.9km	12	55
Plettenberg Bay	45.6km	7	42
Stilbaai	39.8km	7	37
Struisbaai	54.4km	8	44

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Variables to explain angler density

Locational

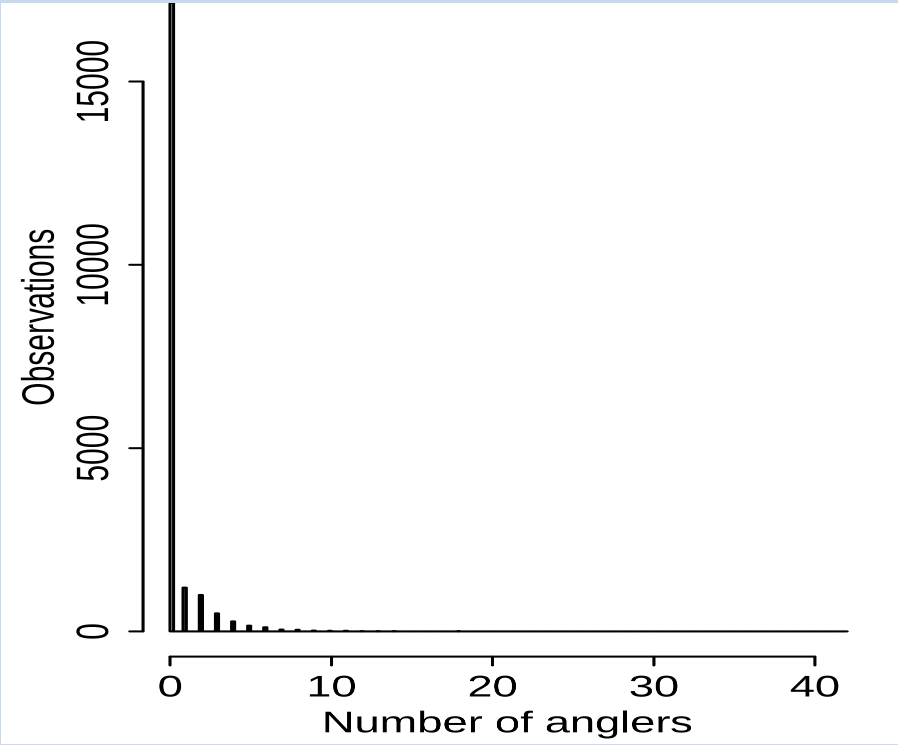
- Coastal area
- Average catch rate (CPUE) as proxy for expected catch
- Physical nature of coastline
  - boulder shoreline, estuary, mixed shoreline, rocky shoreline or sandy beach
- Distance from the nearest vehicle access point (Google Earth)
- Source populations within different distance bands (GIS)
  - 1km, 5km, 10km, 50km and 100km
- Presence of low-income settlements

Temporal

- Time
- Weather
- Season
- School holidays.
- Week day vs weekend

Data challenges

- V high proportion of zeros (83%) in the data (no anglers recorded in a sub-beat).
- NB to understand the source of these zeros (Martin et al. 2005).
  - Observer error – e.g. forgotten GPS, missed the anglers ='false' zero.
  - No anglers used the site that day = 'true' zero.



Analysis

- Data were confirmed to be overdispersed
- The Zero-inflated Poisson (ZIP), negative binomial (NB) and ZINB models all had good fit.
- A Vuong test favoured ZINB over NB (z=-8.49.28, $p<0.001$).
- A likelihood-ratio test favoured ZINB over ZIP ($\chi^2=2158$, $p<0.001$).

Zero-Inflated Negative Binomial (ZINB)		Continuous outcome		Dichotomous outcome		
Variable	**Level**	**Estimate**	**Risk Ratio**	**Estimate**	**Risk Ratio**	
Intercept		-1.14 (0.29)***	0.320	-1.924 (0.28)***	0.146	
Season (vs Autumn)	Spring	-0.42 (0.07)***	0.657	-0.388 (0.20)*	0.679	Most in Autumn followed by Summer, Spring, Winter
	Summer	-0.133 (0.08).	0.875	-0.024 (0.17)	0.976	
	Winter	-0.624 (0.06)***	0.536	0.033 (0.15)	1.033	
Day (vs weekday)	Weekend	1.122 (0.05)***	3.071	-0.149 (0.12)	0.862	3x more on weekends
School (vs holidays)	Term	-0.401 (0.07)***	0.669	0.685 (0.19)***	1.984	More in school holidays
Expected CPUE (fish per 100h)		0.961 (0.24)***	2.613	-1.965 (0.56)***	0.140	Drawn to areas with higher catch rates
Shore Type (vs boulders)	Estuary	1.297 (0.28)***	3.658			Mixed shores and estuaries most popular
	Mixed	1.444 (0.28)***	4.238			
	Rocky	1.273 (0.28)***	3.572			
	Beach	1.168 (0.28)***	3.216			
Distance to access (m)		-0.004 (0.00) n.s.	0.996	0.066 (0.00)***	1.069	Accessibility is a weak factor
Population within 1km		-0.084 (0.02)***	0.920	0.26 (0.06)***	1.297	Hyperbolic
Population within 30km		0.00 (0.00)***	1.000	-0.006 (0.00)***	0.994	
Population within 100km		-0.002 (0.00)***	0.998	0.005 (0.00)***	1.005	
Informal settlmnt w/in 2km	Yes	0.029 (0.08) n.s.	1.030	-1.67 (0.27)***	0.188	Not an issue
Wind speed		-0.019 (0.00)***	0.981	0.009 (0.00).	1.010	Wind a deterrent
Theta		-1.061 (0.05)***				

Risk ratio - indicates the factor change in odds for every unit increase in the respective independent variable

Dichotomous part models the odds of **not observing** an angler at a particular site

Discussion

- Strong seasonal & holiday effect
  - As expected
  - Seasonal closures could have major impact
- CPUE matters more than accessibility
  - suggests anglers may be more catch-sensitive than we think
- Anglers move away from source pops but costs or time restricts travel beyond 30km
  - suggests siting MPAs beyond that

Angler paper 2. Potential impacts of regulatory interventions on the angling at the Breede River estuary

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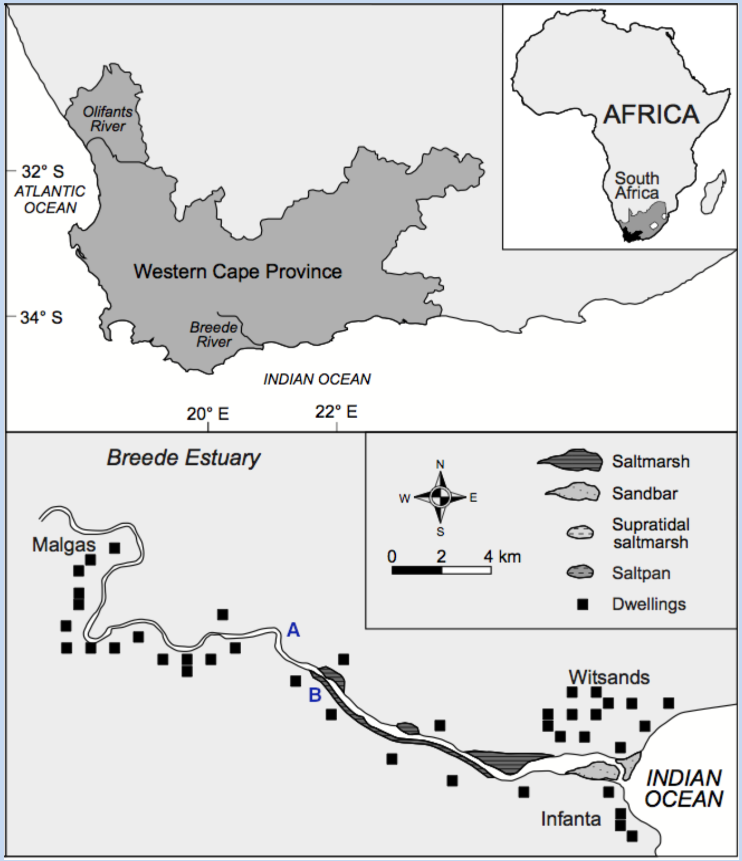
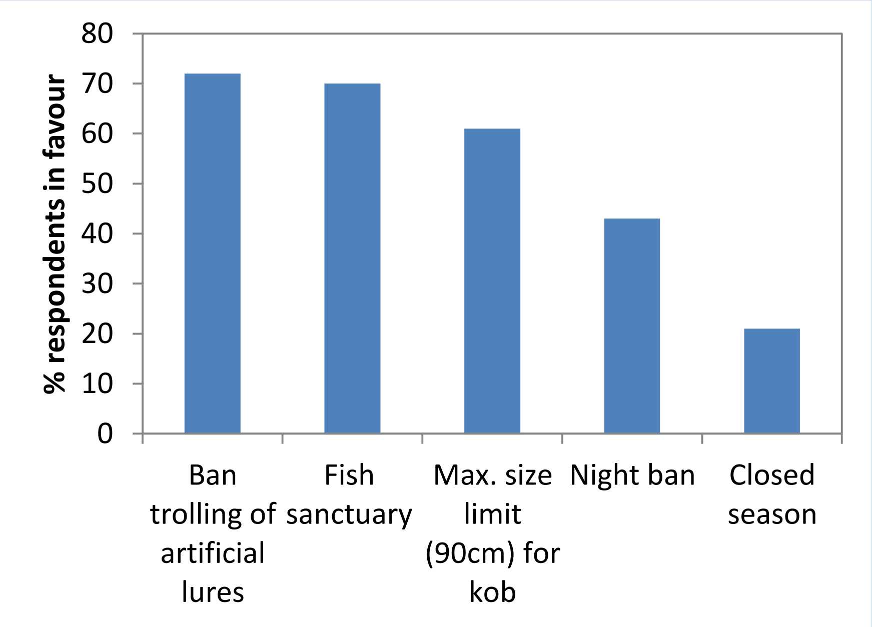
Aim & methods

- Aim – investigate angler preferences and potential responses to alternative management measures to address declining fish stocks at the Breede Estuary.
- Methods - Survey of ~400 resident households and visitor groups during 2011-12. Conjoint rating.



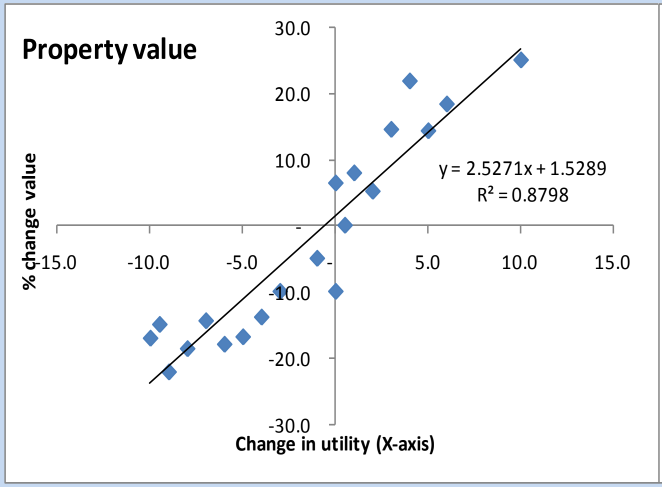
Results

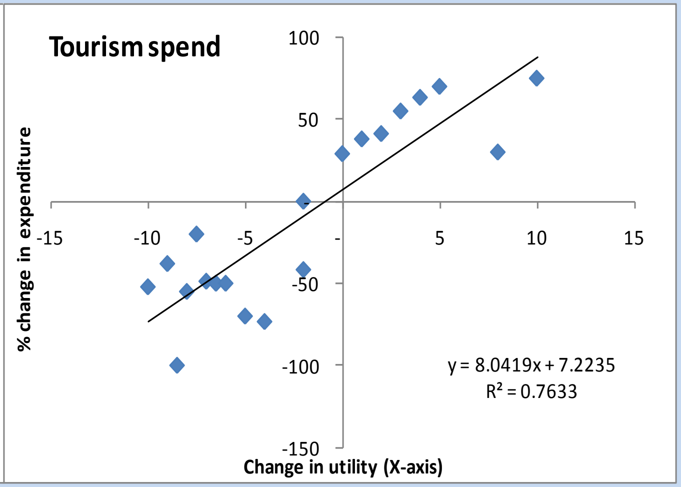
- Angling was the most important attraction of the estuary - >R25 million spent locally.
- Majority of anglers concerned about fish stocks and felt that additional regulations were necessary.
- Majority support for 3 regulations.



Results

- In rating scenarios, anglers were more sensitive to fish abundance than how it was achieved.
- Residents & property owners were more consistent in their estimated response to best and worst scenarios than visitors





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Results

Scenario			Utility rating	Change in property value (%)	Change in visit time (%)
Regulations added	Angling fish (% of present)	Large (>1m) kob (% of present)			
Fish sanctuary	150	125	10.2	10	36
Max size limit for kob	150	125	9.4	8	29
Night ban	150	125	9.1	8	27
Fish sanctuary	110	110	8.6	6	23
Fish sanctuary	100	110	8.3	6	20
Max size limit for kob	100	125	7.7	4	15
Night ban	105	125	7.6	4	15
Night ban	110	110	7.5	4	14
Max size limit for kob	100	110	7.4	3	13
Night ban	110	100	7.3	3	12
Night ban	100	110	7.2	3	11
Night ban + max size limit kob	100	125	7.1	2	10
None	75	100	5.9	-1	1
Night ban + max size limit kob	75	100	5.7	-1	-1
None	100	50	5.7	-1	-1
None	75	0	3.8	-6	-16
None	50	0	3.0	-8	-23
Night ban + max size limit kob	50	0	2.8	-8	-24

- Regulations resulting in increased abundance of fish, and large kob in particular >> positive impact on angling value;
- Further declines in fish stocks could result in up to 24% decrease in expenditure in the area.

Angling work cont’d

- Comparing areas where accessibility has remained constant vs changed since 4x4 ban
- Gearing up for angler surveys in the same areas to investigate motivations for fishing

Paper 3. Meeting global MPA targets – review paper

Turpie et al

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Paper 4. Impacts of the proposed Addo MPA on fisheries

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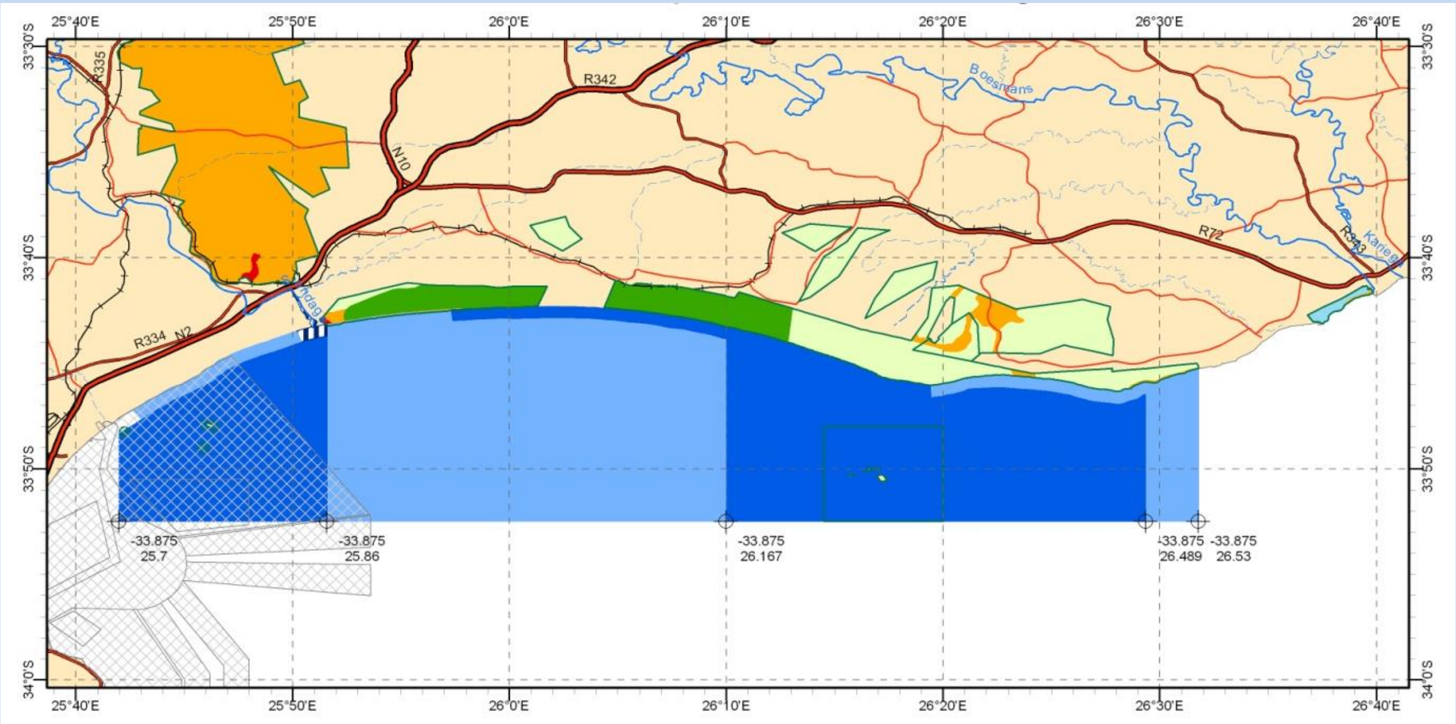
Study area

- About half the proposed MPA in no-take zones



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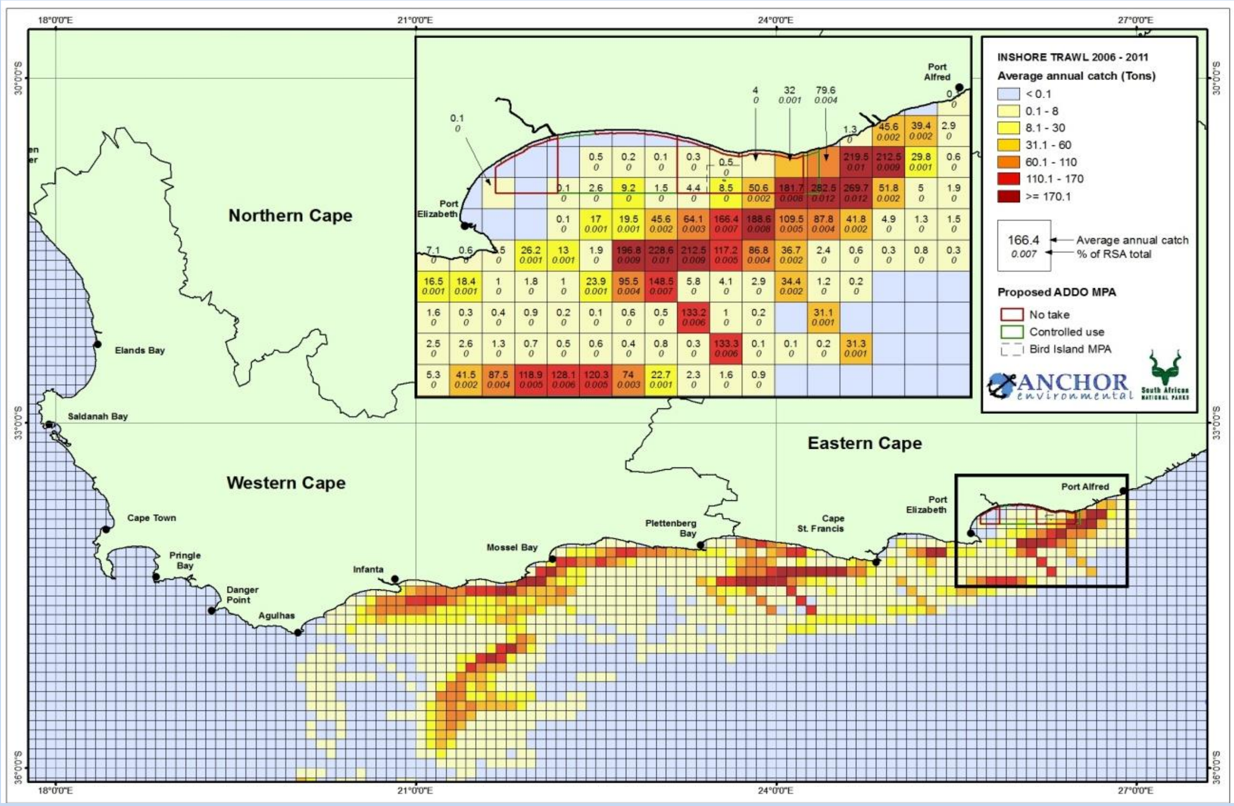
Five affected fisheries

- 2 high capital intensive fisheries
  - inshore trawl
  - small pelagics purse-seine
- 2 less capital intensive fisheries
  - squid jig
  - demersal shark
- 1 small scale/traditional fishery
  - traditional line

Study approach

- Fisheries data obtained from DAFF for 2006 to 2011
- Interviews & focus group discussions
- Simple models developed to estimate impacts



% of catch in no take zone

Fishery	% catch in no take zones
Inshore trawl (whole)	1.3
Small pelagics purse-seine (E Cape)	6.6
Squid jig (whole)	2
Traditional line (Algoa Bay area)	4.1
Shark long-line (PE-based)	20.3

Value of catches in MPA

- The total landed value of catches from within the proposed no-take zones ~ R17.4 million per annum, adding an estimated R42 million to national income and sustaining about 102 jobs in fishing and processing
- Squid and Small Pelagics account for most of this

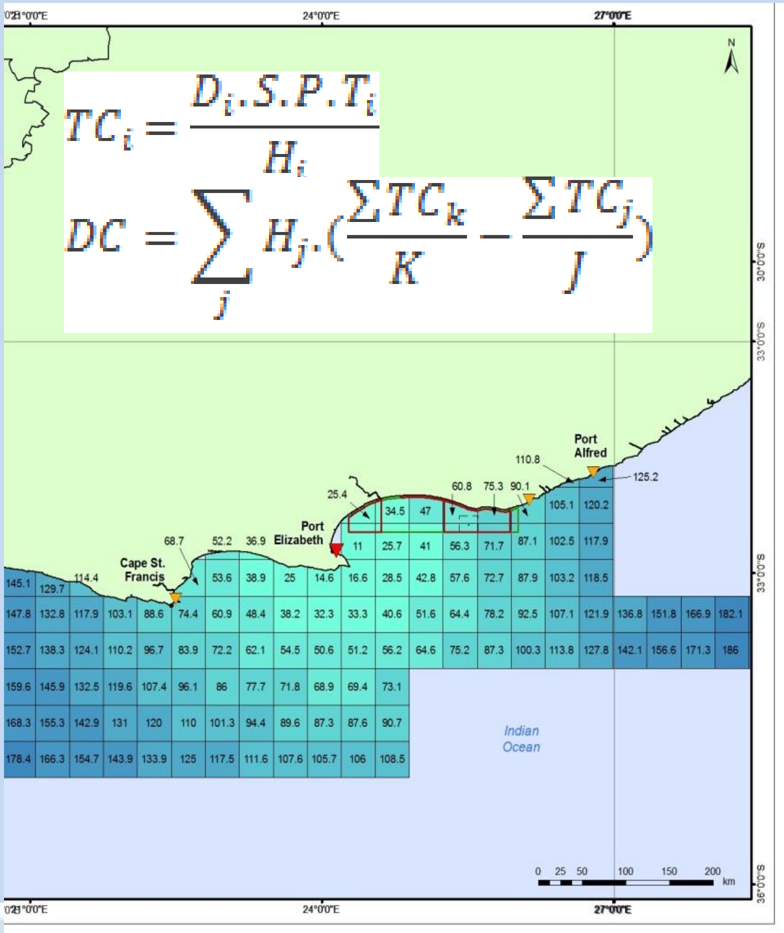
Within no-take zones	Inshore trawl	Small pelagics purse-seine	Squid jig	Traditional line	Shark long-line	Total
Catch(t)	68	**916**	**173**	20.9	18	1196
Landed value (R m)	0.8	**5.4**	**10.4**	0.5	0.3	17.4
Final output value (R m)	5.1	**7.9**	**14.5**	3.7	0.6	31.8
Total value added (R m)	6.6	**10.3**	**19.0**	4.9	0.7	41.6
Jobs (fishing + processing)	2	**33**	**53**	9	5	102

Impacts

- Fishing effort will be relocated. Nevertheless:
- (A) the net value of fisheries may be compromised due to
  - (i) increased travel costs,
  - (ii) spatial discrepancies in catch rates and/or values in favour of the MPA area,
  - (iii) reductions in stocks and CPUE outside the MPA as a result of relocated effort (congestion effects), or
  - (iv) temporal unavailability when a large portion of the stock in MPA for an extended period.
- (B) there may be a benefit in terms of fish exports from MPA

Travel costs of relocation

- Travel costs – assumed optimal behaviour observed; displaced fishing effort follows same.
- Very small/negligible for trawl, small pelagics, and squid
- Traditional line - cheaper
- Shark - additional travel costs = 1.5% of landed value



$$TC_i = \frac{D_i.S.P.T_i}{H_i}$$

$$DC = \sum_j H_j.\left(\frac{\sum TC_k}{K} - \frac{\sum TC_j}{J}\right)$$

Spatial discrepancies in catch rates and/or values

		CPUE outside	Value/t outside	Costs
Catch-limited	**Inshore trawl**	Higher	3% higher	Unlikely
	Small pelagics purse-seine	Slightly lower	Same	Requires 1% increase in effort: <0.01% of landed value
Effort-limited	**Squid jig**	Higher (6%)	Same	Unlikely
	Traditional line	Higher	Higher	No costs under present scenario*
	Shark long-line	Lower	Higher	Loss of catch value: 3.9%

Congestion, mobility & spillover effects

- **Depletion due to congestion**
  - Only likely for linefishing on reefs
- **Temporal unavailability of stocks** can amplify impacts in any one year.
  - Shark long-line – 20% on average, but up to 50%
- **Spillover benefits** – resident species recover and contribute to stocks outside MPA
  - Only significant for linefishery.

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Overall results

	Inshore trawl	Small pelagics (E Cape)	Squid jig	Traditional line (Algoa Bay)	Shark long-line (PE)
Relocation & effort	-R0.005 m	-R0.083 m	-R0.29 m	R0.07 m	-R0.02 m
Catch value	R0.05 m	-	R0.63 m	-R0.48 m - +R0.33 m	-R0.05 m
Gains from MPA	-	-	-	R2 m	-
Net gain/loss	**R0.05 m**	**-R0.083 m**	**R0.34 m**	**R1.62 – 2.4 m**	**-R0.07 m**
% of value of the fishery	**0.0%**	**-0.1%**	**0.1%**	**13.5 - 20%**	**-5.4%**

MPA project ongoing

- Investigating impacts on MPA establishment along Kogelberg coast (small-scale linefishing and lobster)

Other projects

From cost minimisation to economic efficiency in conservation planning

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Aim and approach

- Investigated how outcomes change when ecosystem service benefits and livelihood values are explicitly considered in conservation planning
- Estimated opportunity costs
  - commercial and subsistence agriculture,
  - consumptive use of natural resources
- Benefits of conservation included regulating and cultural ecosystem services
- Analysis using Marxan optimisation software

Results

- Inclusion of economic benefits resulted in gains in economic efficiency (net benefit maximization).
- Explicitly considering economic benefits produced an outcome with a cost: benefit ratio 6 times greater than when no economic variables were considered (9.45 vs. 1.55).
- Application of livelihood weightings causes reserve systems to became dispersed in homelands, increasing costs (difference of R7 billion).
- Disregarding economic benefits may compromise the implementation potential of proposed reserves, particularly when the economic benefits of competing land-uses are brought to the table. Furthermore, it is important to explicitly consider the social costs of conservation or compensation costs among the trade-offs

Next year

- Continuation of MPA project – year 3 comparative analysis
- Ecotourism and sensitivity to environmental quality – St Lucia estuary
- Predator conservation: Impact of compensation schemes on lion killing by Maasai

Dealing with zero-inflated data

- **Transformation** of the dependent variable
  - not adequately when v high abundance of zeroes
- **Separation of the data** into two groups, those where the outcome is zero and those where the outcome is greater than zero (Karazsia et al. 2008).
  - ignores meaningful variation
- **Mixture models or conditional models**
  - two-part models or hurdle models

Conditional & mixed models

- These models consists of a zero mass, the so-called 'hurdle', typically described with a logit model, and a truncated form of a standard continuous or discrete distribution.
  - The zero mass is thus modelled independently of the non-zero values, and the covariate effects on presence/absence can be interpreted separately from the effects on abundance.
- Mixed models also have a degenerate distribution with mass at zero, but differ from conditional models in that the non-degenerate distribution is not zero-truncated, and zeros can thus arise from both parts of the model.
- Zero-inflated mixed models were introduced by Lambert (1992) using a poisson distribution but the term can apply to any distribution to indicate that there are more zeros than would be expected on the basis of the non-zero counts in the data.
- Specification of a mixed model allows assessment of the likelihood that a zero arose from the degenerate zero mass as opposed to the non-degenerate part of the model, while the conditional models handle the zeros separately from the non-zeros.
- As the conditional model treats all zeros in the same manner, the mixed models are more useful for analysis of data where a large proportion of sampling or "false" zeros is expected (Zuur et al. 2009). In this case, we expect sampling zeros and so the mixture models are more appropriate than the conditional models

The dependent variable

- Angler density, is logically represented by a continuous probability function,
- However, in the model we used angler count with the length of the sub-beat included as an offset term.
- This allowed us to model the integer-value count of anglers for each beat, but interpret our model coefficients as impacts on angler density

Model options

- Poisson
  - restrictive in its assumption that the mean and variance of the count variable are equal
  - Quasi-poisson model beetter for overdispersed data as it relaxes the above assumption
- Negative binomial,
  - better designed to deal with overdispersion than the poisson models, and includes a dispersion parameter
  - However if this is a result of a high proportion of zeros in the data, may result in biased parameters and standard errors
- Zero-inflated poisson (ZIP) and
  - will reflect data accurately if the overdispersion is caused by the large number of zeros
- Zero-inflated negative binomial models (ZINB).
  - more appropriate if there is overdispersion beyond what is attributable to the inflated number of zeros
- Post-hoc statistical tests are available to assess model fit. The negative binomial and ZINB models can be compared with the Vuong test (Vuong 1989). The ZIP and ZINB models are nested and so can be compared with a likelihood-ratio (LR) test.