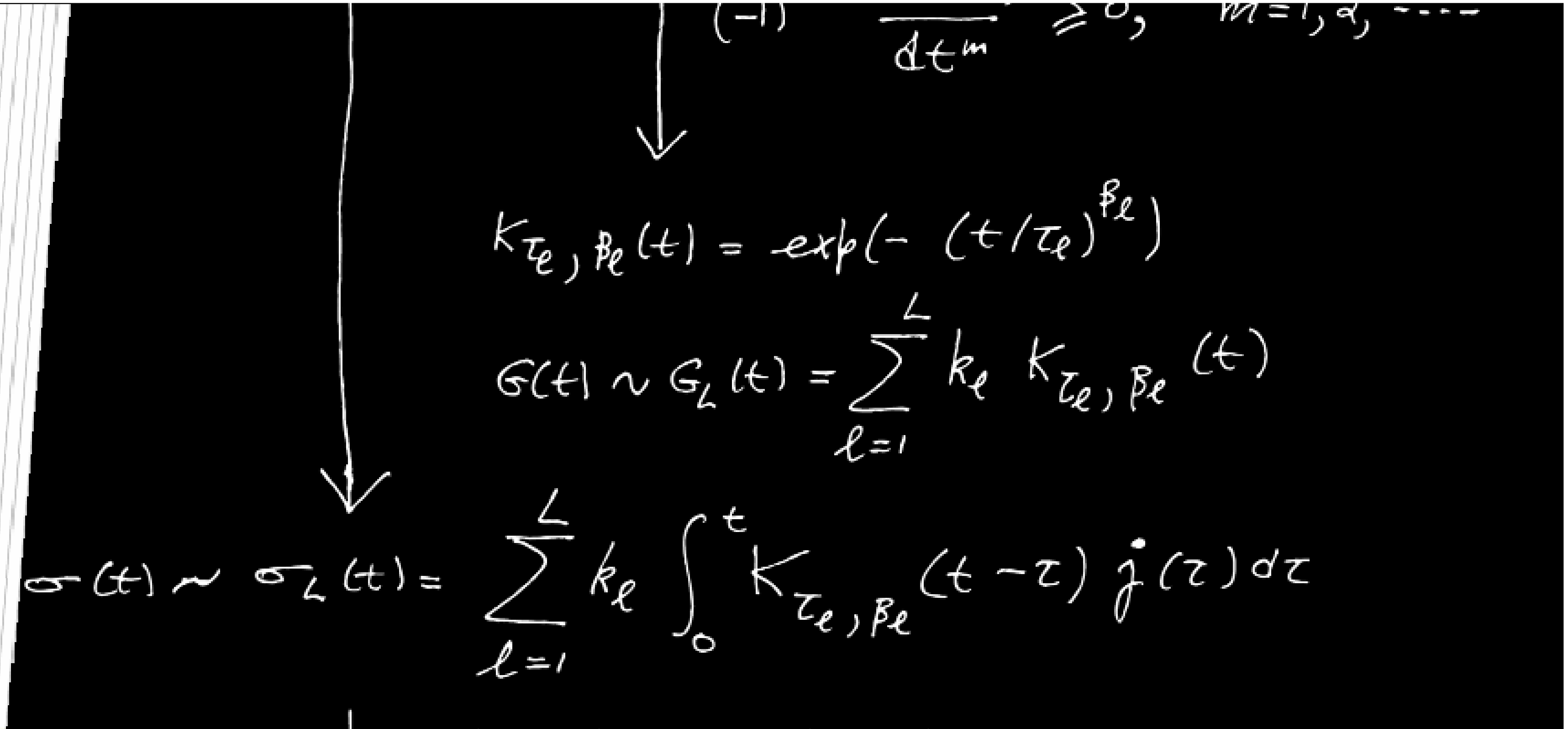

An Empirical Relationship between Changes in Headrope Length and Catch for the NPF

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The data: catch and effort

- Years 1987-2006 (cf 1991-2002 in ET study)
- Response: Total catch C =T+E+K+B (cf T + E/2)
- Second season only
- Scale: logbook records aggregated to a total catch, and (nominal) effort, E (in boat days),
  - for each vessel and
  - each stock region
- JBG excluded as largely a banana fishery.
- Hence each vessel contributes up to 6 C & E values for each second season in the study

The data: catch predictors

- Vessel related measurements:
  - The headrope length carried that season: H (in fathoms)
  - The rated engine power, P (in KW)
  - The underdeck tonnage, U (in standardized hull units)
  - A random term for vessel as a surrogate for unmeasured or unmeasurable items.
- 'Abundance' and fishing power surrogates
  - A fixed effect term for the stock region ('productivity' differences)
  - A random term for the season itself (global abundance shifts and fishing power)
  - A random interaction between stock region and year

Headrope and engine power: a fleet profile over time

The statistical model

- The main relationship (y = "year", s = "stock", v = "vessel")

$$\log C_{ysv} = \beta_0 + \beta_H \log H_{vs} + \beta_P \log P_{vs} + \beta_U \log U_{vs} + \beta_E \log E_{ysv} + \gamma_v + \rho_s + \delta_y + \tau_{rs} + \varepsilon_{yvs}$$

- Fixed terms

$$\beta_0, \beta_H, \beta_P, \beta_U, \beta_E (\approx 1), \rho_s$$

- Random terms

$$\gamma_v \sim N\left(0, \sigma_\gamma^2\right), \quad \delta_y \sim N\left(0, \sigma_\delta^2\right), \quad \tau_{ys} \sim N\left(0, \sigma_\tau^2\right)$$

Results

	Effort Trade-offs		*Present study*	
	Value	Std Error	Value	Std Error
Intercept	2.0223	-0.2383	2.2705	-0.1664
Headrope	0.3132	-0.0768	0.3105	-0.0461
Engine power	0.1664	-0.0600	0.1389	-0.0345
Hull size	0.1524	-0.0424	0.1885	-0.0282
Effort	1.1450	-0.0063	1.1463	-0.0044

Variance components

	Vessel	Years	Stocks within years	Residual
Effort trade-offs	0.09541	***0.00021***	0.26487	0.44102
Present study	0.09793	***0.19288***	0.21303	0.41596

Connection between relative changes

- Let C and H denote catch and headrope length. Then

$$C_0 \propto H_0^{\beta_H}$$

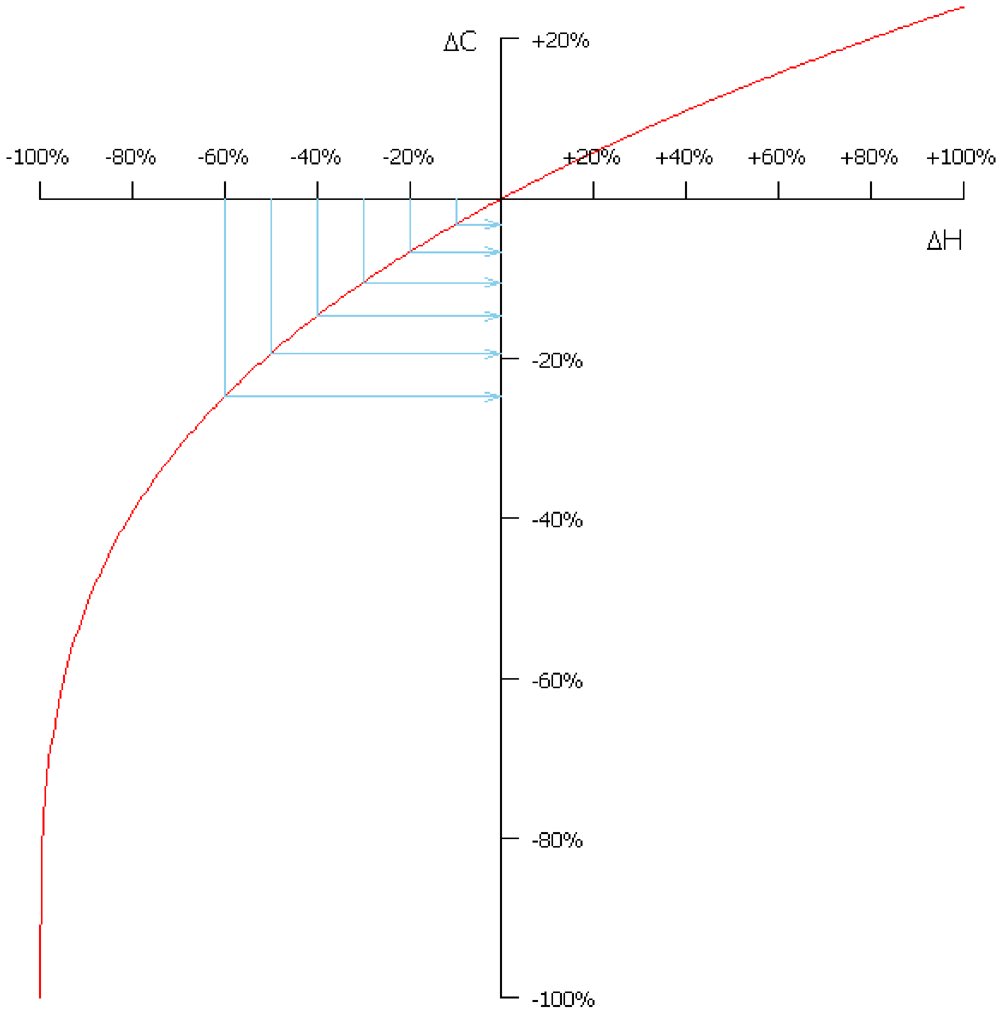
$$C \propto H^{\beta_H}$$

$$\frac{C}{C_0} = \left(\frac{H}{H_0} \right)^{\beta_H}$$

$$\frac{C - C_0}{C_0} + 1 = \left(\frac{H - H_0}{H_0} + 1 \right)^{\beta_H}$$

$$\Delta C = \left(1 + \Delta H \right)^{\beta_H} - 1$$

$$\Delta C = (1 + \Delta H)^{0.3105} - 1$$



The final relationship in a form suitable for increases or decreases.

Stability over time spans

Estimates of beta_H from 5-year time windows covering 1987-2006.

The horizontal dotted line shows the estimate from the complete time period.

Effort equivalent changes

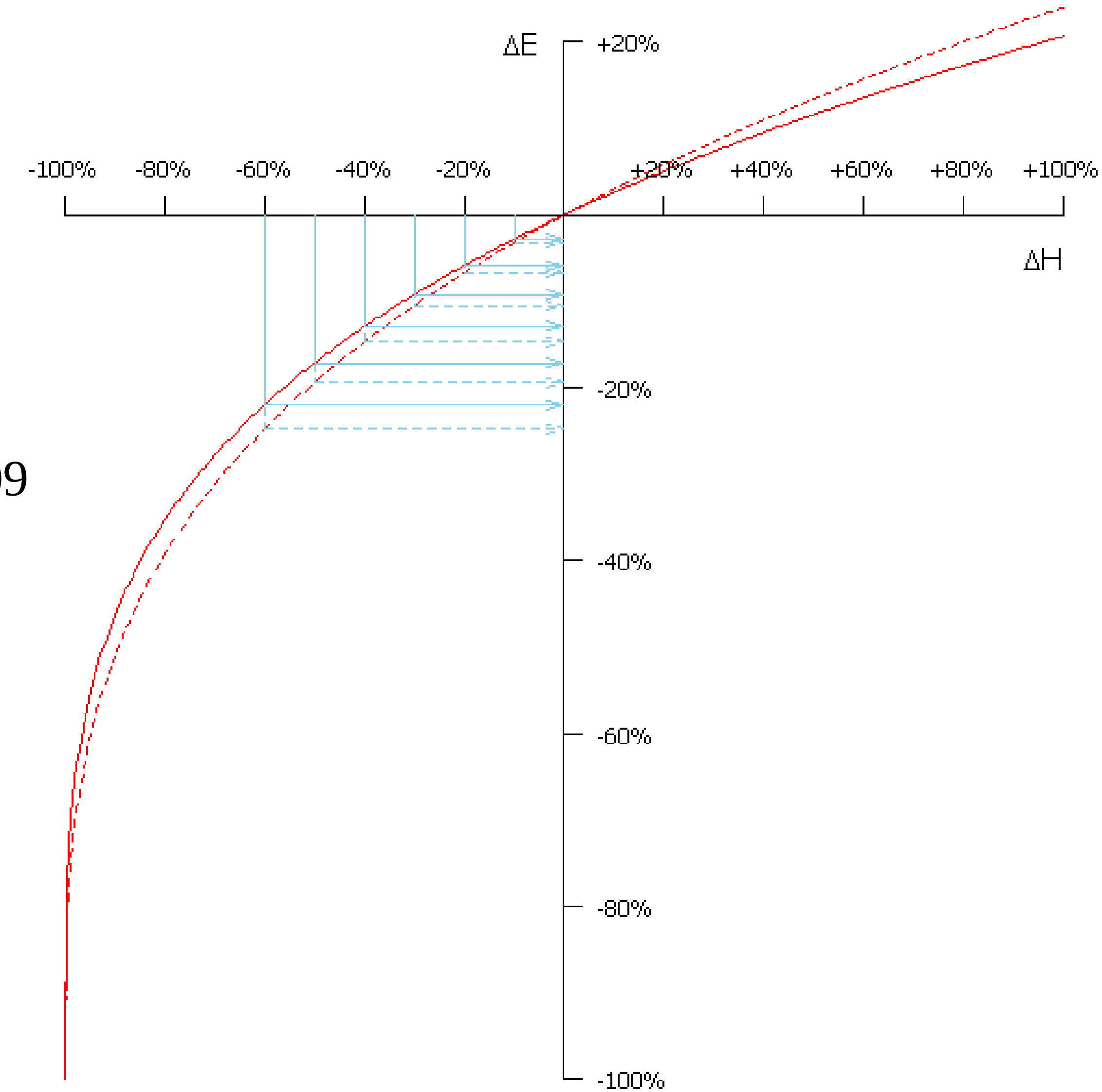
- A relative change to headrope length on a vessel produces an expected relative change to catch
- The model we have uses nominal effort as a predictor of catch
- The model implies that $C = kH^{\beta_H} E^{\beta_E}$
- Suppose changing $H \to H_0$ changes $C \to C_0$
- Suppose changing $E \to E_0$ also changes $C \to C_0$
- Hence $kH_0^{\beta_H} E^{\beta_E} = C_0 = kH^{\beta_H} E_0^{\beta_E}$
- Rearranging gives $\left(\frac{H}{H_0}\right)^{\beta_H} = \left(\frac{E}{E_0}\right)^{\beta_E}$
- The punchline: $\Delta E = (1 + \Delta H)^{\beta_H / \beta_E} - 1$

$\left(\Delta H = (H - H_0)/H_0\right.$ is the relative change$\left.\right)$

Catch and effort together

$$\hat{\beta}_H / \hat{\beta}_E = 0.3105/1.1463 = 0.2709$$

$$\Delta E = (1 + \Delta H)^{0.2709} - 1$$



Final remarks

- We offer an assessment, based on an empirical model, of the consequences on catch if the fleet were to change headrope, *keeping all other factors constant*
- Offers a 'fleet-eye' view of the consequences on *catch*, not *profit*
- Extends Effort Trade-off study in several ways
  - Slightly more effective model
  - 20 years' data rather than 12
  - Study of stability over time windows within the period
  - Slightly modified definition of catch
  - Increases and decreases in headrope considered
  - Investigations at a lower time scale
- Overall result of Effort Trade-offs confirmed
- The fleet can respond to management-imposed headrope unit changes in a variety of ways
- The work can also be used to arrive at a *notional* link between headrope changes and effort – for Economic MSE.

Suggested AFMA policy for data collection from the NPF fleet

Every breath you take
Every move you make
Every bond you break
Every step you take
Ill be watching you …

Every single day
Every word you say
Every game you play
Every night you stay
Ill be watching you …

Every move you make
Every vow you break
Every smile you fake
Every claim you stake
Ill be watching you …

- The Police