

# Vessel-level modelling of discarding in Scottish fisheries

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# “Mapping and modelling the incentives for a landing obligation in demersal fisheries” (FIS06)

- A six-month study funded by FIS (2015)
- Interactive simulation model (MS Excel)
- Illustrating discarding for industry/policy makers
- Context: demersal landing obligation 2016-
- Based on economic theory (rational behaviour)
- Accompanying survey of trawler skippers in NE Scotland
- Modelling discarding behaviour of a “typical” North Sea whitefish trawler (TR1) or *Nephrops* trawler (TR2)

# Economic model

- Profit function with  $i = 1, 2, \dots, N$  quota species

$$\sum p_i [h_i e - d_i] - \sum r_i q_i - ce - \gamma \sum [h_i e - d_i - q_i] - \omega \sum d_i \\ + \lambda [L - \sum [h_i e - d_i]] + \mu [E - e]$$

- Discarding condition (hold constraint not binding)

$$p_i + \omega = r_i, \quad i = 1, 2, \dots, N$$

- Discarding condition (hold constraint binding)

$$[p_i - r_i] + \omega = \lambda, \quad i = 1, 2, \dots, N$$

- Optimal effort ( $e^* < E$ )

$$\sum [p_i - r_i] h_i - c = \lambda \sum h_i$$

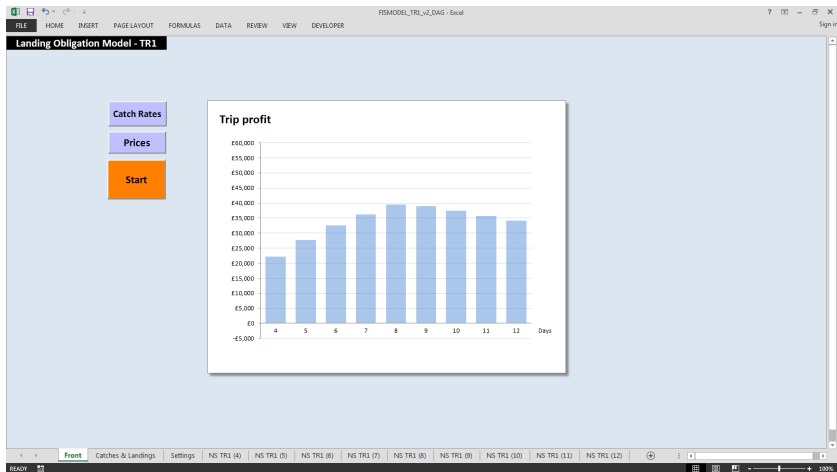
# Simulation model - features/constraints

- Calculates catches, landings, discards and profits per trip
- LO can be imposed for different species
- Trip basis (in order to model hold constraint)
- Crew and boat costs paid from trip profits
- Includes (2) size grades and undersize fish
- Undersize fish counted against quota if a LO in force
- Problem of quota limits per trip...
- Choke species: inelastic quota supply/high quota price?

# Simulation model - features/constraints

- Discarding/over-quota costs: expected or “psychic” penalties
- Discarding cost ignored if no LO in force
- Undersize fish automatically discarded if no LO in force
- Most valuable fish counted against quota limits first
- Quota price ignored for fish within quota limits
- If the hold constraint binds, least valuable fish discarded first
- Note: with or without a LO, fish is discarded when the hold is full
- Main problem: requires *many* parameters!

# Model front page



# Catch rates

The screenshot shows an Excel spreadsheet titled "Landing Obligation Model - TR1". On the left side, there are three buttons: "Catch Rates" (purple), "Prices" (purple), and "Start" (orange). A dialog box titled "Catch rates - NS TR1" is open in the center, displaying a table of fish species and their catch rates. The table is titled "Catch rates (kilos per day)".

Species	Catch Rate (kilos per day)	% large fish	% under MCRS
Haddock	2000	20	5
Whiting	2500	20	5
Cod	750	10	5
Salthe	2500	20	10
Plaice	250	20	10
Sole	150	20	10
Hake	1250	20	10
Nephrops	100	20	20
Others	3000	20	5

The spreadsheet interface includes a ribbon with tabs for FILE, HOME, INSERT, PAGE LAYOUT, FORMULAS, DATA, REVIEW, VIEW, and DEVELOPER. The status bar at the bottom shows "READY" and "100%" zoom.

# Prices

The screenshot shows an Excel spreadsheet titled "Landing Obligation Model - TR1" with a "Prices - NS TR1" dialog box open. The dialog box displays "Ex vessel prices (pence per kilo)" for various fish species, organized into columns for L, S, and US prices. The background spreadsheet shows a "Trip price" column with values ranging from -£5,000 to £60,000. The dialog box has a title bar "Prices - NS TR1" and a close button. The spreadsheet has a ribbon with "FILE", "HOME", "INSERT", "PAGE LAYOUT", "FORMULAS", "DATA", "REVIEW", "VIEW", and "DEVELOPER". The status bar at the bottom shows "READY" and "100%".

Species	L	S	US
Haddock	200	220	0
Whiting	160	50	0
Cod	280	220	0
Saithe	200	80	0
Plaice	120	40	0
Sole	450	250	0
Hake	300	300	0
Nephrops	400	200	0
Others	140	110	0



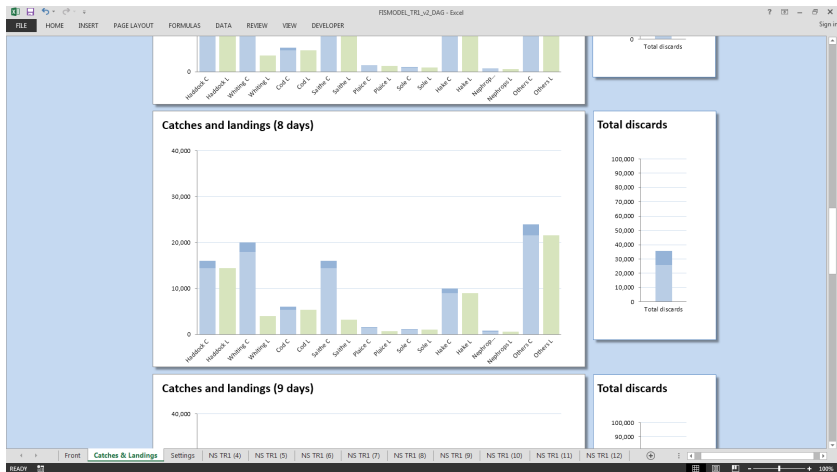
# Main control panel

The screenshot shows an Excel spreadsheet titled "Landing Obligation Model - TR1" with a control panel for a simulation. The spreadsheet has a ribbon with "FILE", "HOME", "INSERT", "PAGE LAYOUT", "FORMULAS", "DATA", "REVIEW", "VIEW", and "DEVELOPER" tabs. The control panel is titled "Landing Obligation Simulation - NS TR1" and contains the following sections:

- Fishing cost per day (£)**: 4200
- Fish room capacity (kg)**: 60000
- Regulation (pence per kilo)**:
  - Discard cost (LO): 10000,  Deducted?
  - No quota cost: 10000,  Deducted?
- Quota prices (pence per kilo)**:
  - Haddock: 50
  - Whiting: 35
  - Cod: 150
  - Saithe: 60
  - Plaice: 0
  - Sole: 100
  - Hake: 175
  - Nephrops: 100
  - Others: 20
- Landing obligation?**:
  - Haddock
  - Whiting
  - Cod
  - Saithe
  - Plaice
  - Sole
  - Hake
  - Nephrops
  - Others
- Trip quotas (kilos)**:
  - Haddock: 0, Saithe: 0, Hake: 0
  - Whiting: 0, Plaice: 0, Nephrops: 0
  - Cod: 0, Sole: 0, Others: 0

The spreadsheet interface shows the "Front" sheet selected, with a tab bar containing "Catches & Landings", "Settings", and multiple "NS TR1" sheets (4) through (12). The status bar at the bottom indicates "READY" and "100%" zoom.

# Catches and landings

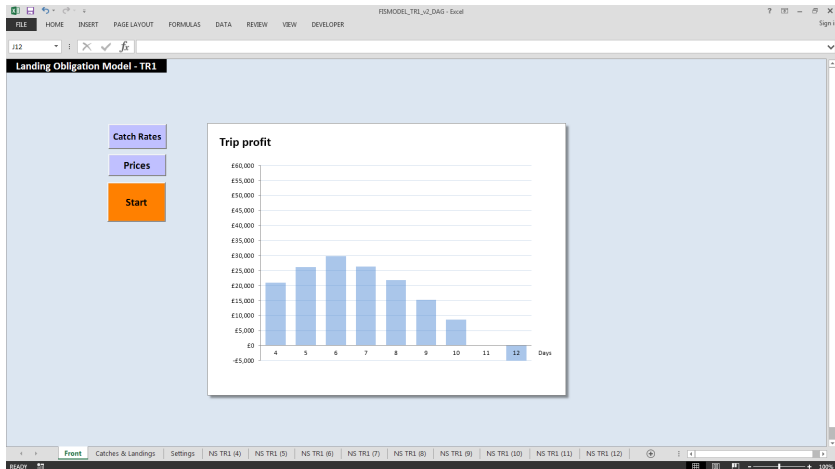


# Example

- North Sea whitefish trawler (TR1)
- Fish room capacity 60 tonnes
- Running costs £4,200 per day
- All quota leased
- Profits maximised on 8 day trip (approx. £40k)
- Hold full on day 5
- Discards of marketable whiting and saithe as well as *all* undersize fish
- Impact of a LO for haddock, plaice, whiting and cod...

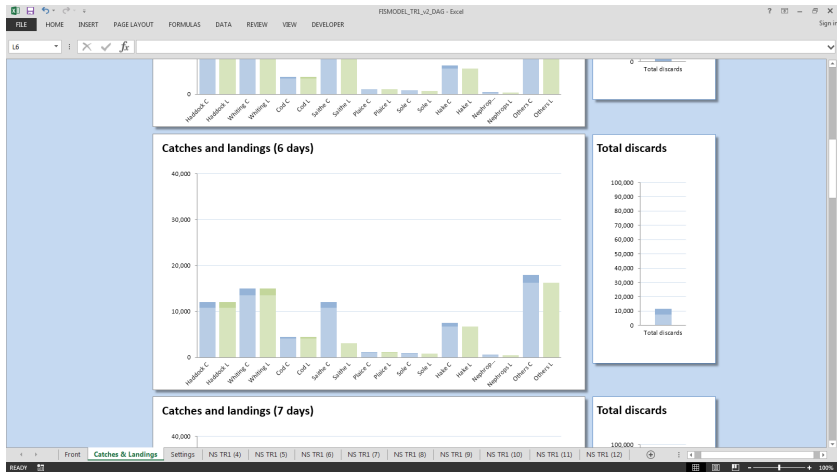
# Example: trip profits

- Profits decrease after 6 days as undersize LO fish have to be retained at the expense of marketable non-LO fish



# Example: landings and discards

- Quantities in kilos: darker bars represent fish below MCRS



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