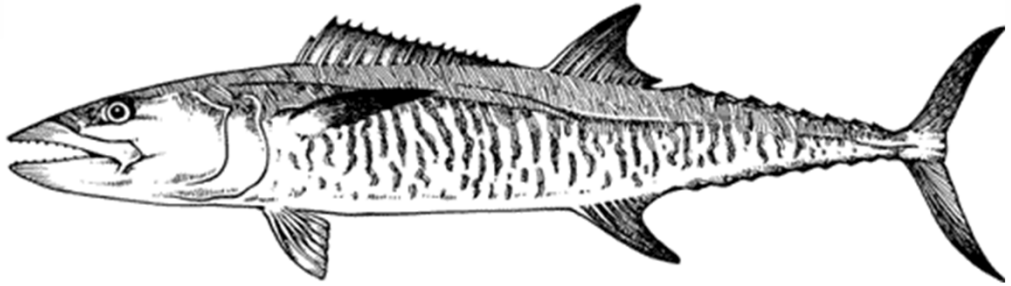


Scomberomorus commerson

Spanish mackerel

Updated stock assessment to 2017-18, and harvest strategy development

RAG meeting November 2018

Talk outline – stock assessment

- Data inputs – assessment information.
- Outputs – stock assessment predictions.
- Harvest strategy options – **example** reference points and control rules.

Meeting reference – agenda item 5, p181

Stock assessment

Data sources → **Traditional** | **Commercial TS and leased** | **Recreational** | **Charter** | **PNG** | **Monitoring** | **Research**

Data inputs → **Total harvests** | **Standardised catch rate** | **Age structure**

Age structure → **Weight at age** | **Maturity at age** | **Sex ratio at age** | **Fecundity at age**

Model → **Estimated abundance of fish (this year)** =

Number of fish (last year)
-
Natural mortality
-
Fishing mortality
+
Recruitment
+
Growth

Outputs →

Model estimates:
Historic stock size
Reference points

Important changes since 2014-2015

- Major
  - Estimates of total harvests (less).
  - Catch rates (declined)
  - Estimating recruitment variation

- Minor
  - Merged gender calculations in stock assessment

Definitions

- Fishing year was labelled using the first year in the financial year string. For example the financial year July 2017 to June 2018 was labelled as 2017 fishing year.

- Catch rate = relative index of legal sized fish abundance. This was standardised (adjusted) to a constant average fishing vessel through time.

- $B_{LIM} = B_{20\%}$, biomass limit reference point. The point below which the risk to the population is regarded as unacceptable.

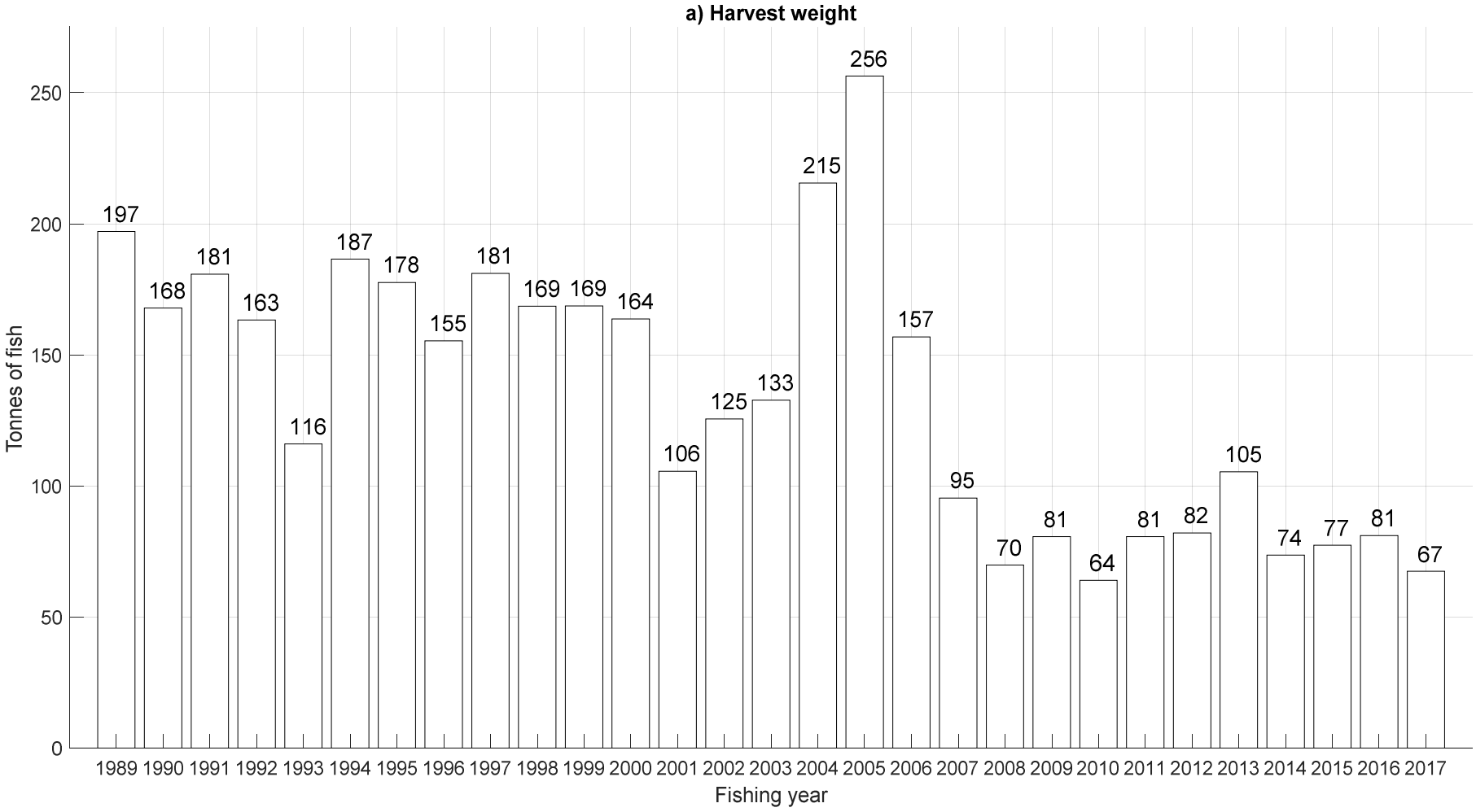
- $B_{MSY} \approx B_{40\%}$, biomass at maximum sustainable yield; values below are not desirable and changes to management are actioned.

- $B_{TRP} = B_{60\%}$, the desired target biomass of the population.

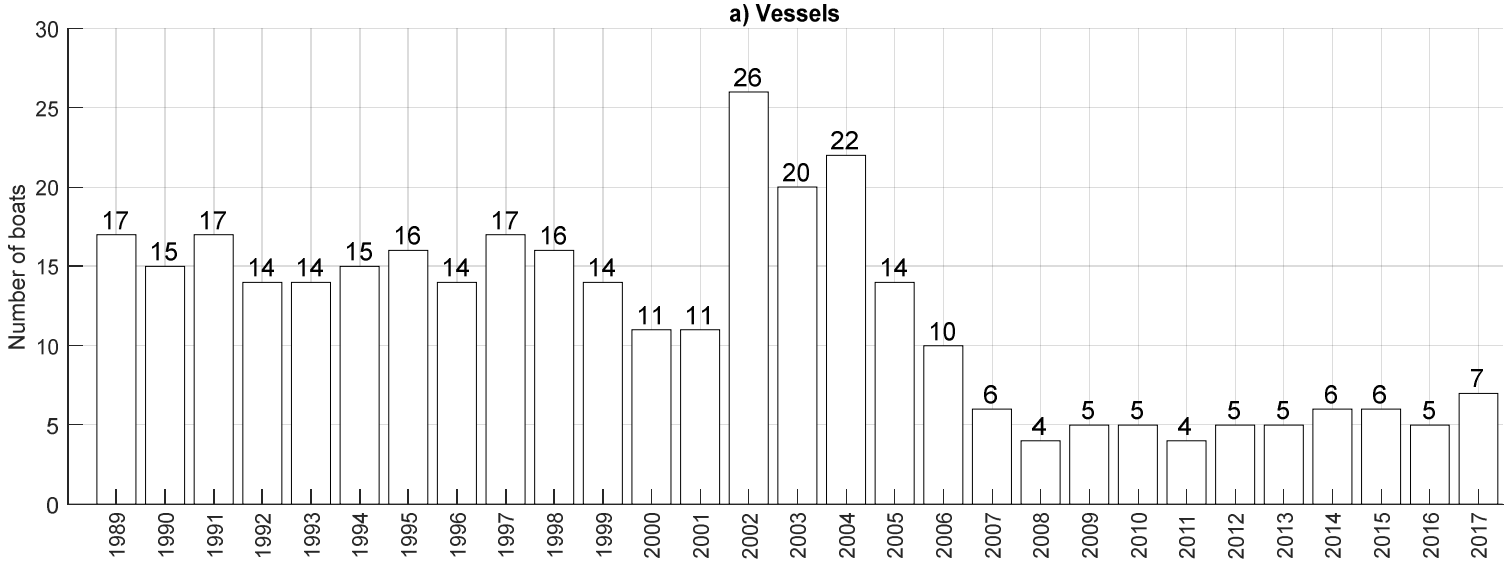
Data - biology

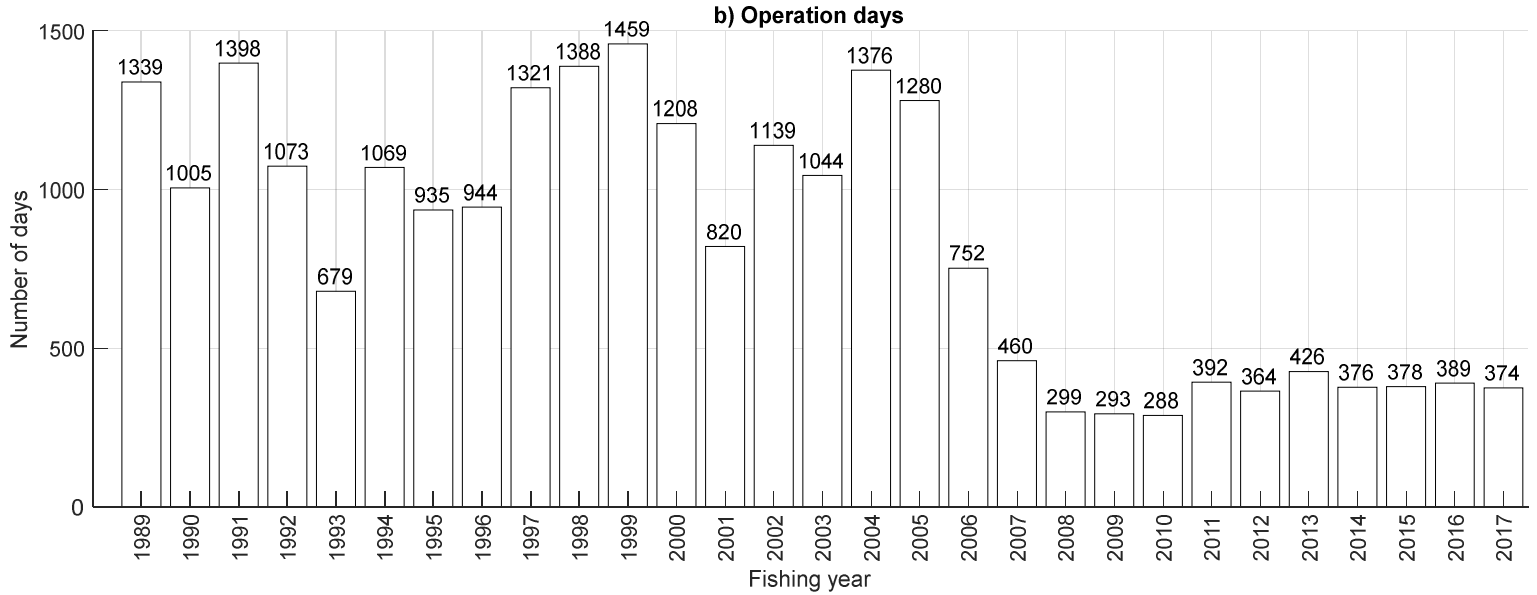
- Oldest fish (longevity) from the:
  - Torres Strait = 12 years
  - East Gulf of Carpentaria = 15 years
  - Queensland east coast = 26 years
- Age maturity 2 to 4 years
- Fish can grow to:
  - 160-180 cm total length
  - weigh 20 to 30 kg
- Female fecundity about 75000 eggs per kg
- Natural mortality? 18% : 25% : 32% per year

Data - estimated harvest from logbooks (mainly from leased/TVH licenses)

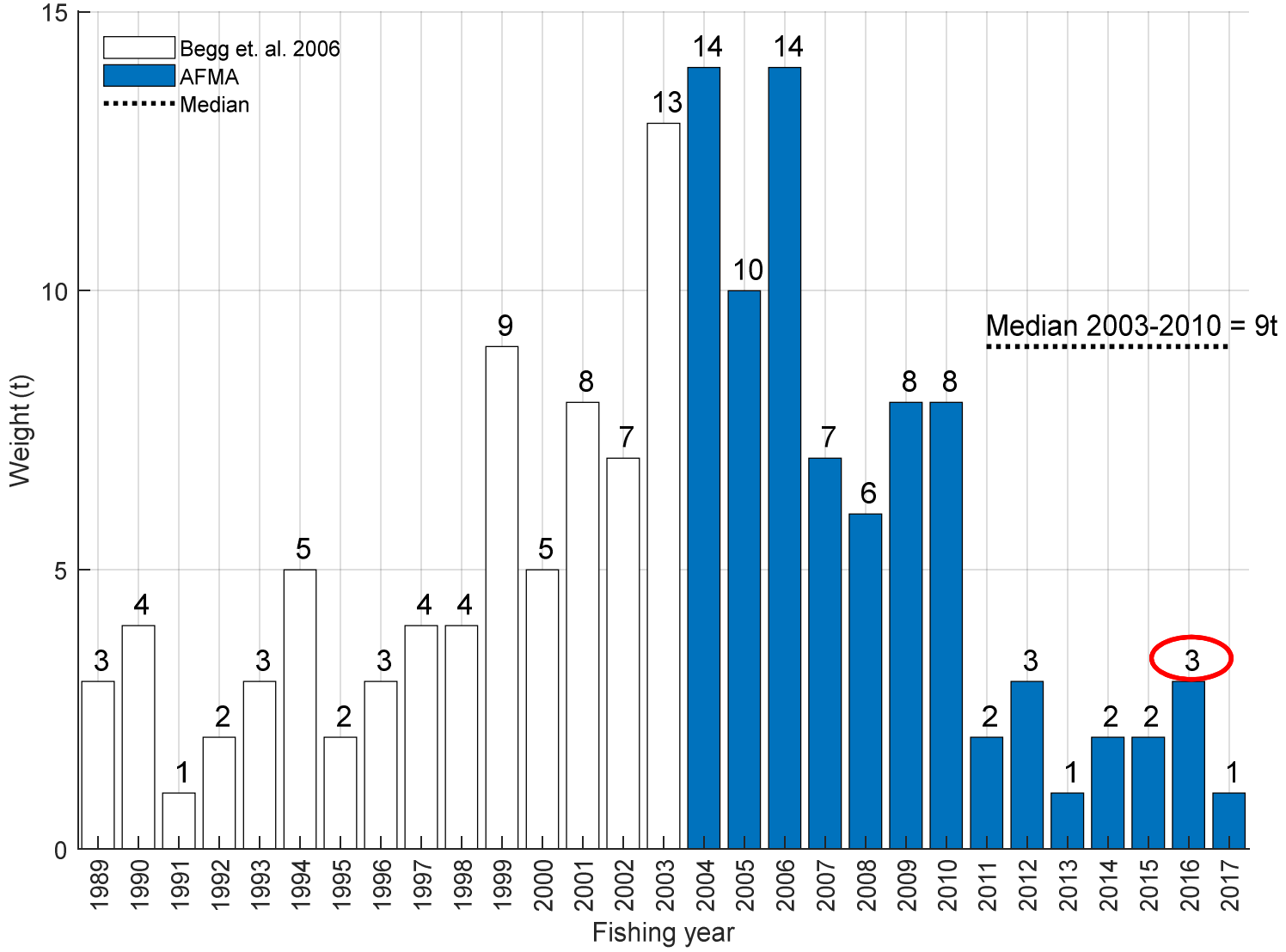


Data – nominal effort from logbook





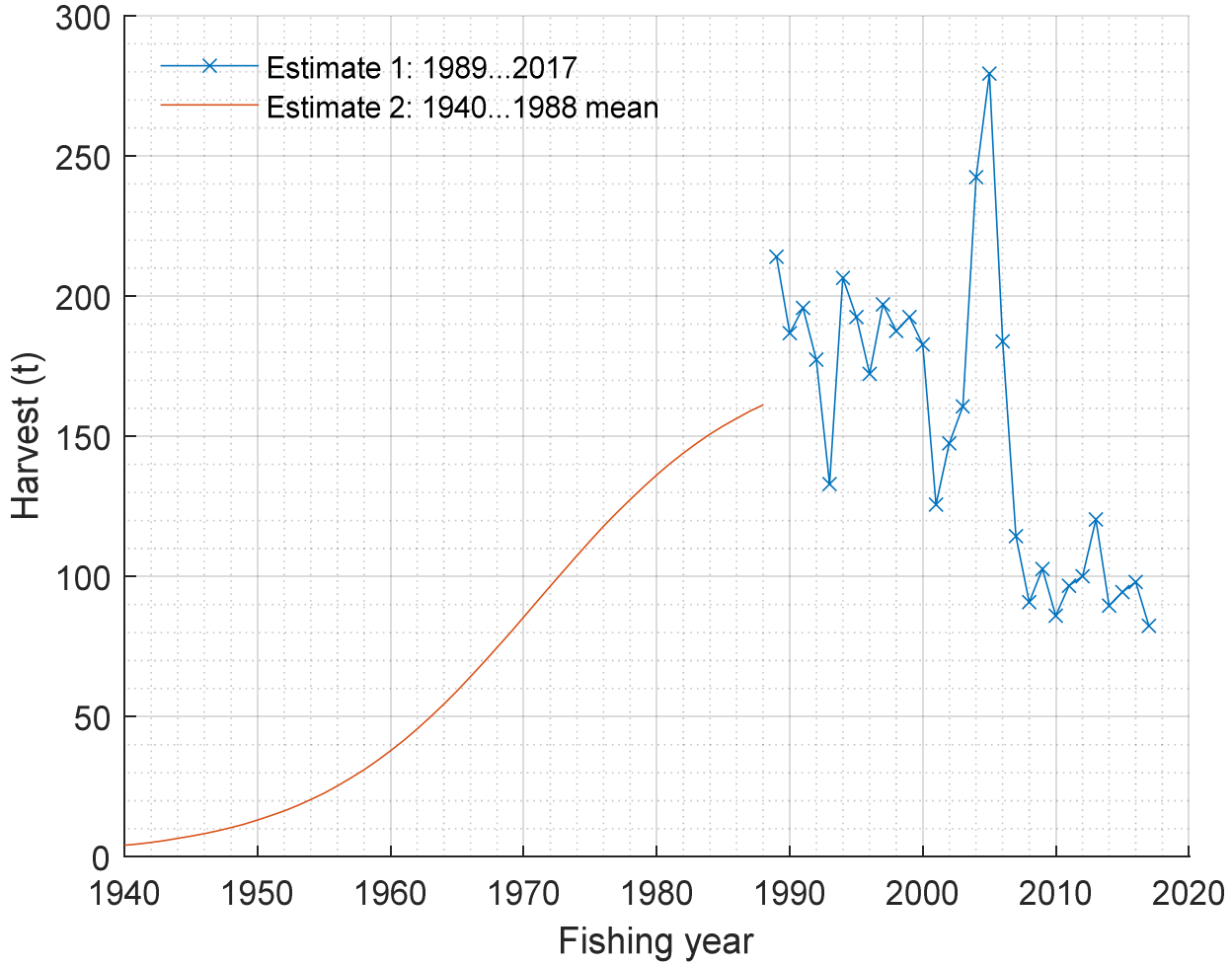
Data - estimated harvest from docket book (TIB licenses)



Data – current total annual harvests

- Commercial harvest (TIB) ≈ 2-11 t
- Islander traditional harvest ≈ 10 t
- Leased commercial harvest (TVH) ≈ 77 t
- Charter ≈ no information; assumed in rec estimate
- Recreational ≈ 2 to 5 t
- Papua New Guinea ≈ 0 t

Data - estimated combined harvests (all fishing sectors)

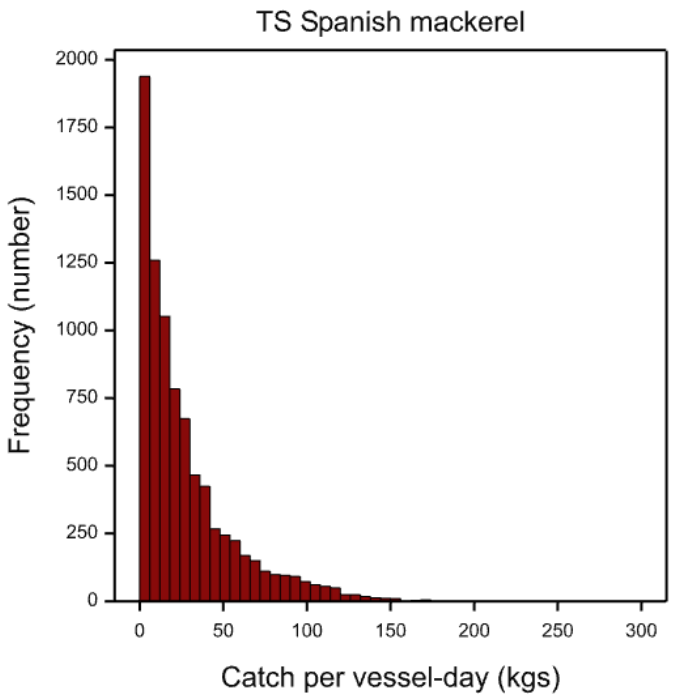


Data – catch rates from TSF01 logbook

quality assessment fishing years ≥ 2003

Units = number of fish harvested per boat day

Number of observations = 8396
Number of missing values = 0
Mean number of fish = 28
Median = 18
Minimum = 1
Maximum = 276
Lower quartile = 7
Upper quartile = 38
Standard deviation = 30
Coefficient of variation = 105%
Skewness = 1.912 (yes; asymmetrical)
Kurtosis = 4.866 (yes; has long upper tail of distribution)
Box-cox lambda = 0.11



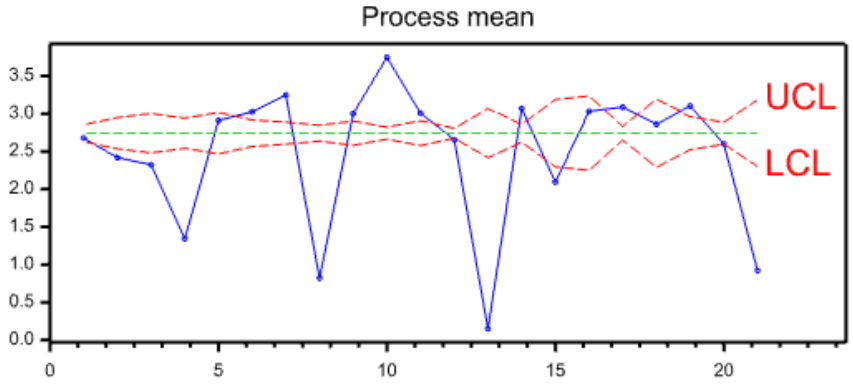
Data – catch rates from TSF01 logbook

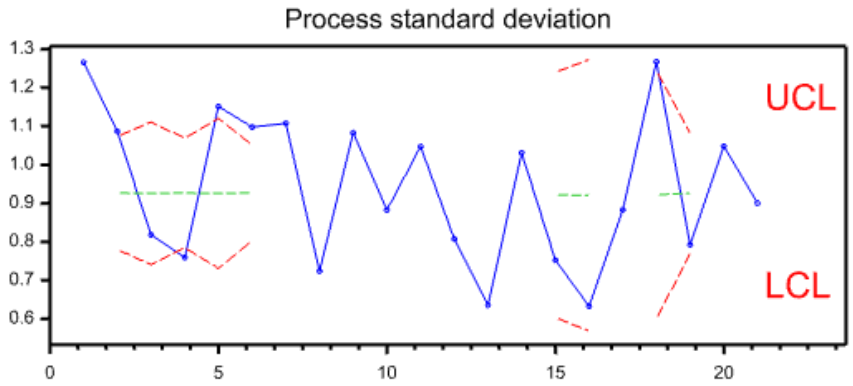
quality assessment fishing years ≥ 2003

Units = log number of fish harvested per boat day

X-axis = boats

Shewhart control charts for mean and standard deviation





Data - method for standardised catch rates

- Generalised linear models (GLM) for standardised catch rates
  - Over dispersed Poisson

- Standardised catch rates (numbers) of Spanish mackerel per vessel operation day

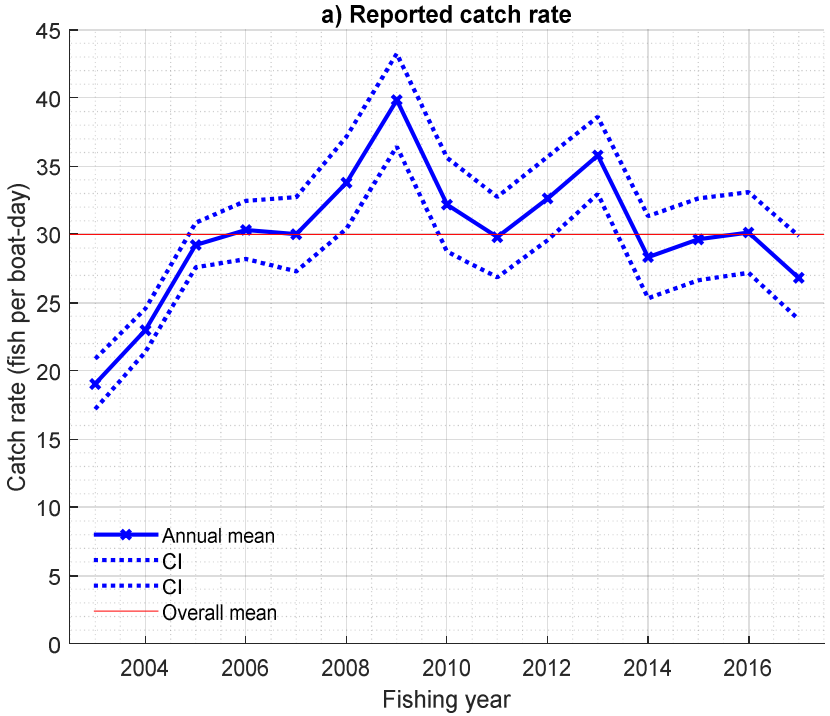
  ~ annual average catch rates adjusted to a constant average vessel operation, fishing season, number of tenders, hours fished, lunar cycle, wind strength*direction. (logbook type dropped).

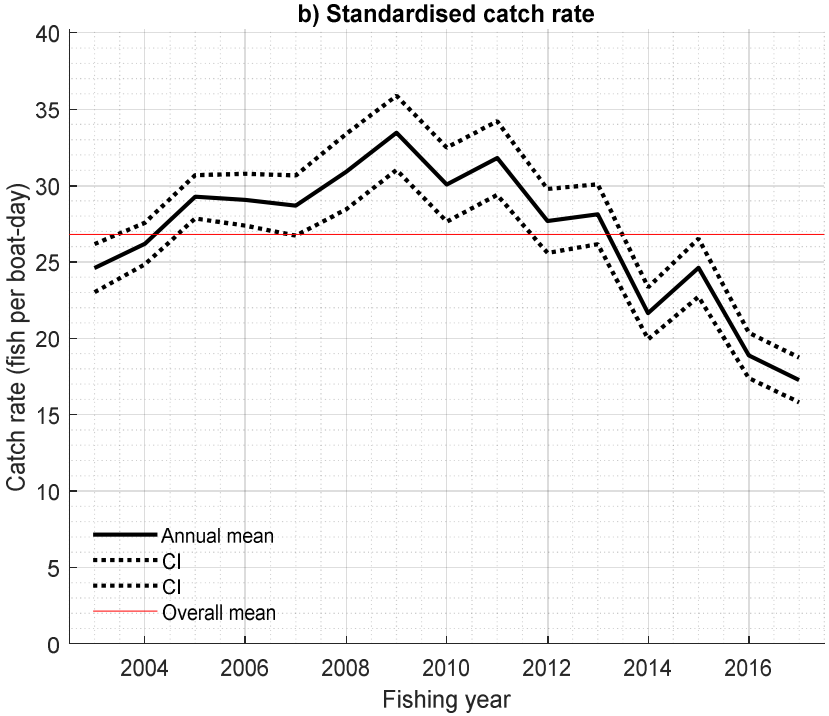
- Assumptions:
  - No change in fishing power by vessel operations; vessel differences were estimated.
  - No spatial information.
  - No zero catches.
  - No “hours fished” before 2003.

Data – catch rates from TSF01 logbook

fishing years ≥ 2003

Units = number of fish harvested per boat day



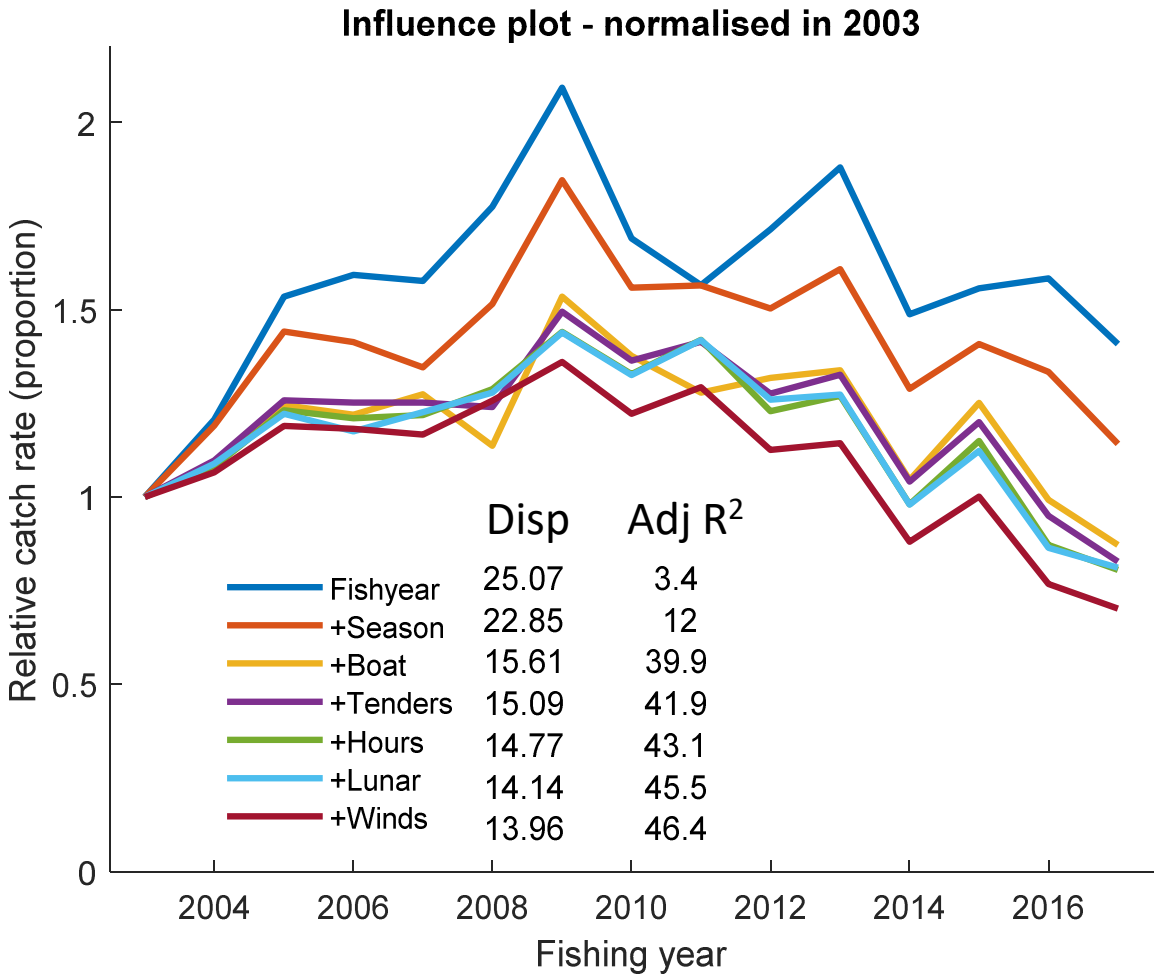



```
MODEL [DISTRIBUTION=poisson; LINK=logarithm; DISPERSION=*] nfish
fishyear+boat+s1+s2+s3+s4+tendersn+hours+lunar+lunar_adv+
pol(windns;2)+pol(windew;2)
```

Data – catch rates from TSF01 logbook

fishing years ≥ 2003

Units = relative proportion per boat day



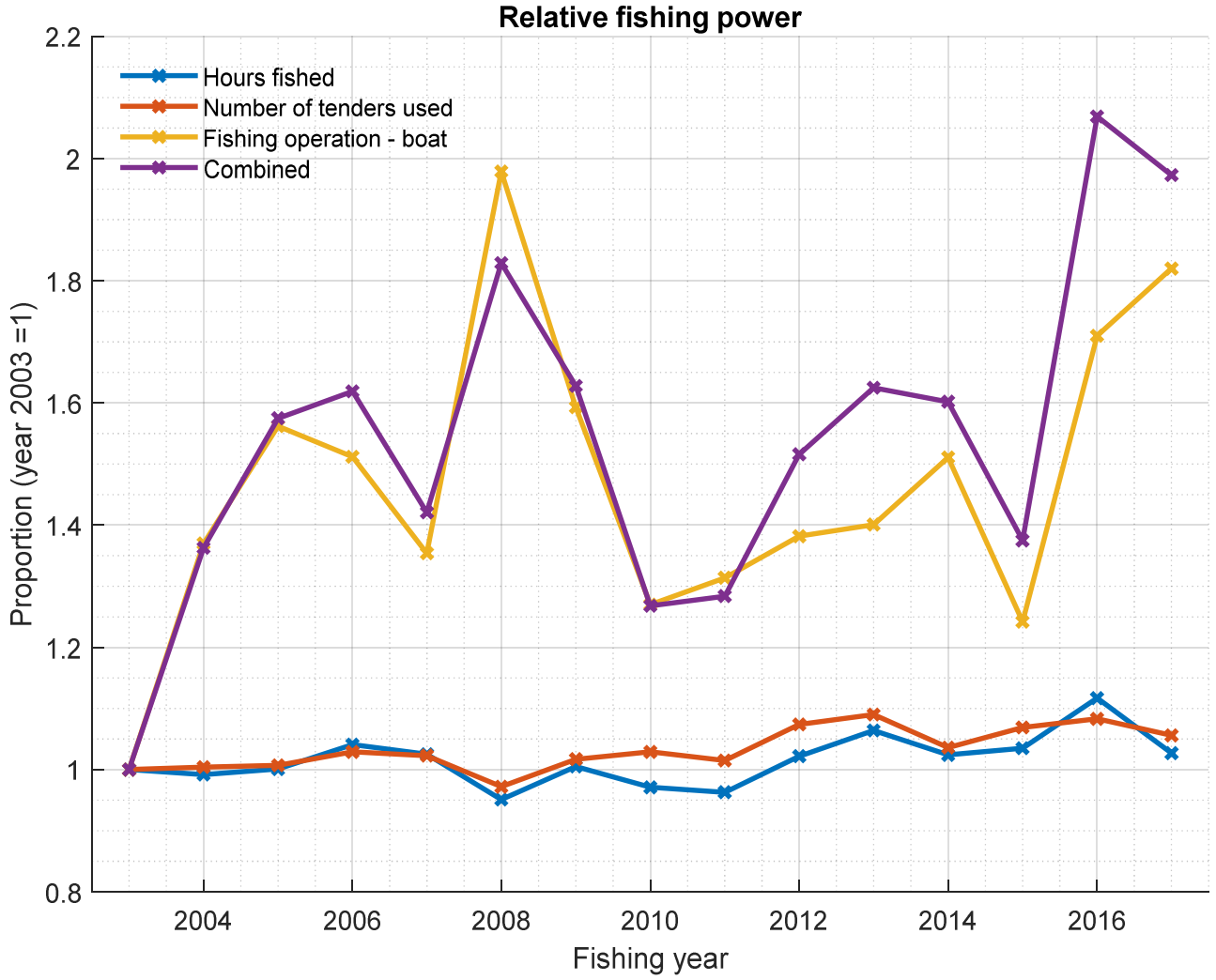
Power to detect annual changes in catch rates (fish abundance):

≈ 4 fish; or 15%

Data – catch rates from TSF01 logbook

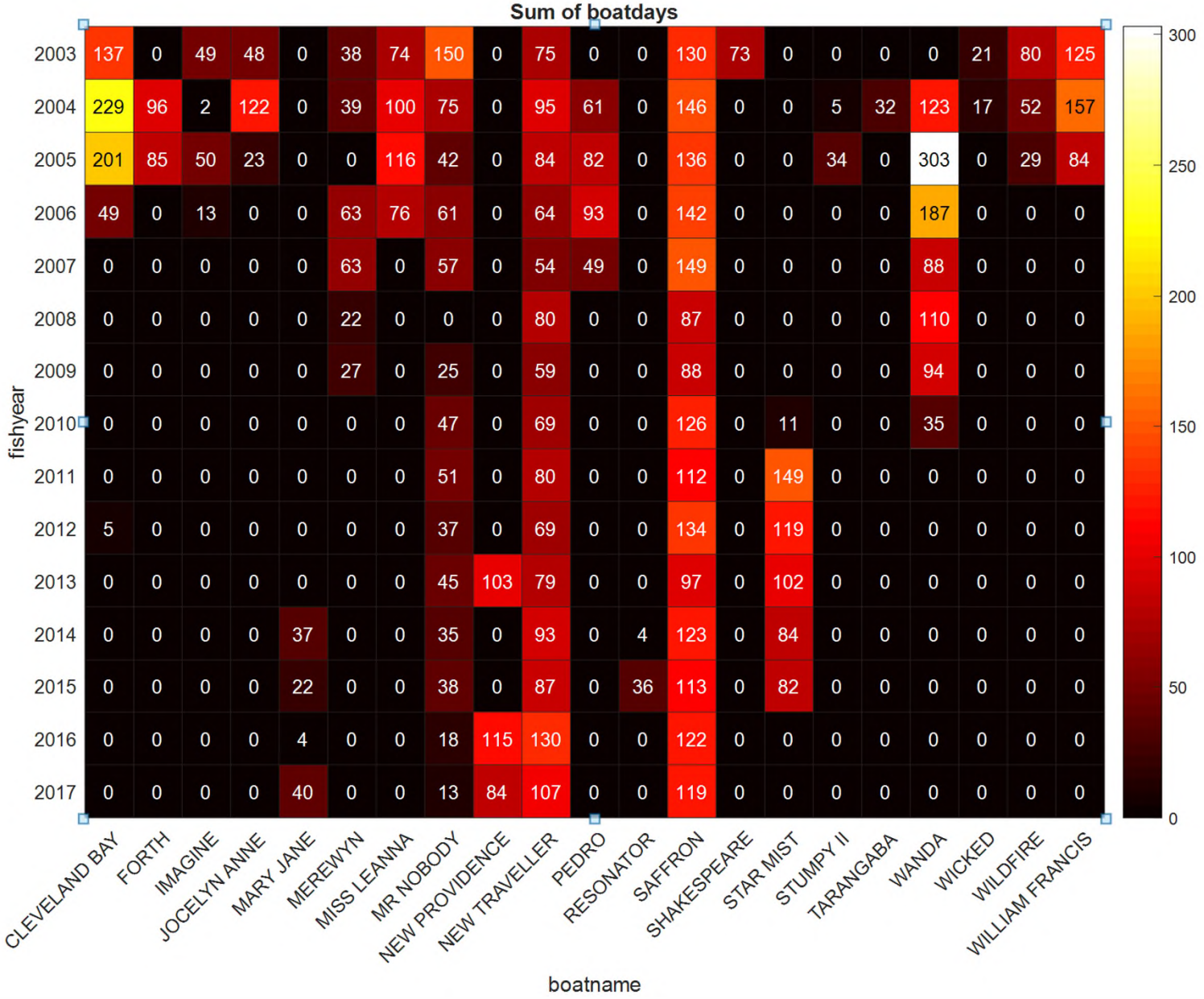
fishing years ≥ 2003

Units = relative proportion fishing power



Data – catch rates from TSF01 logbook

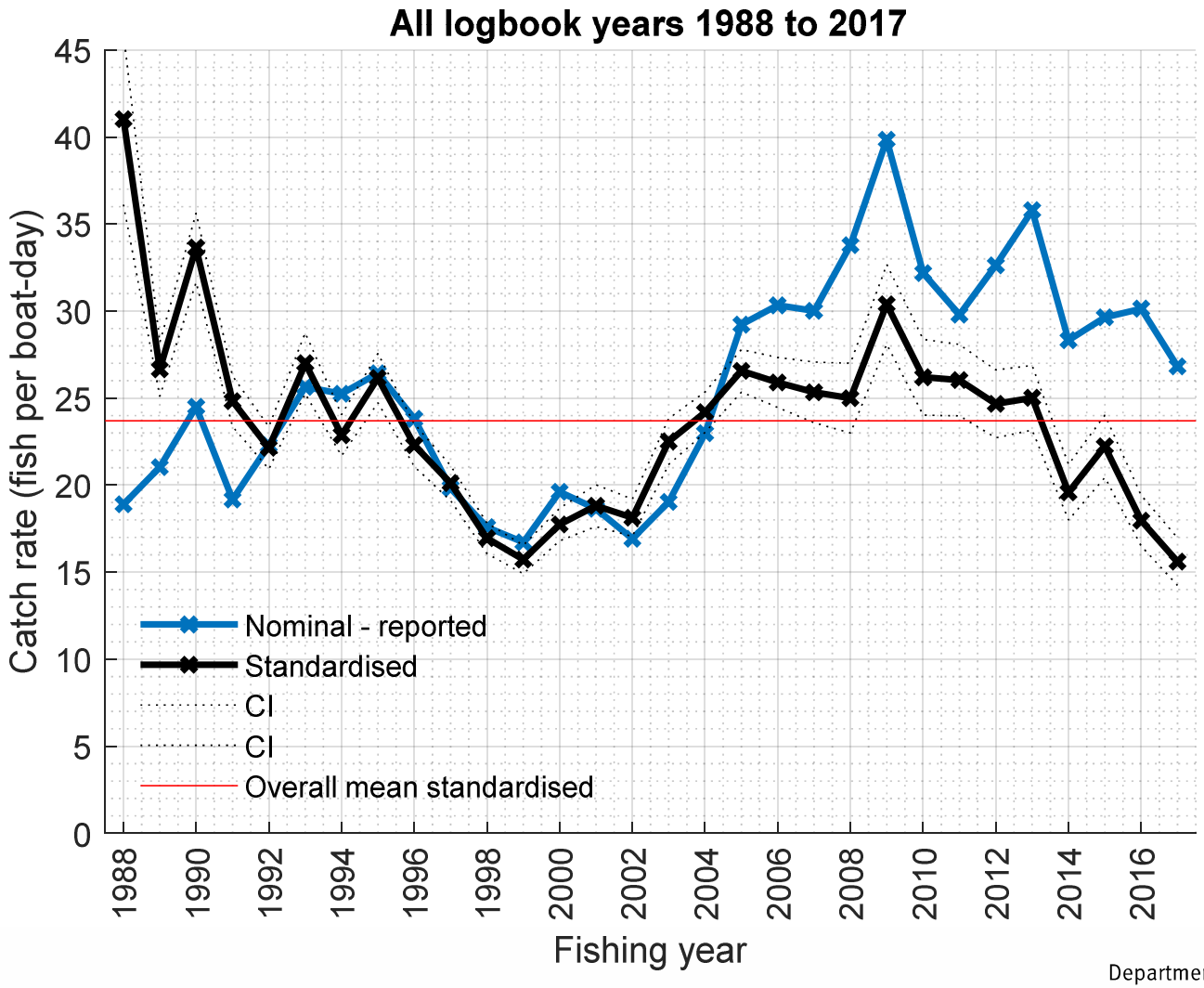
fishing years ≥ 2003; Units = boat day days



Data – catch rates from SM02 and TSF01 logbooks

fishing years ≥ 1988

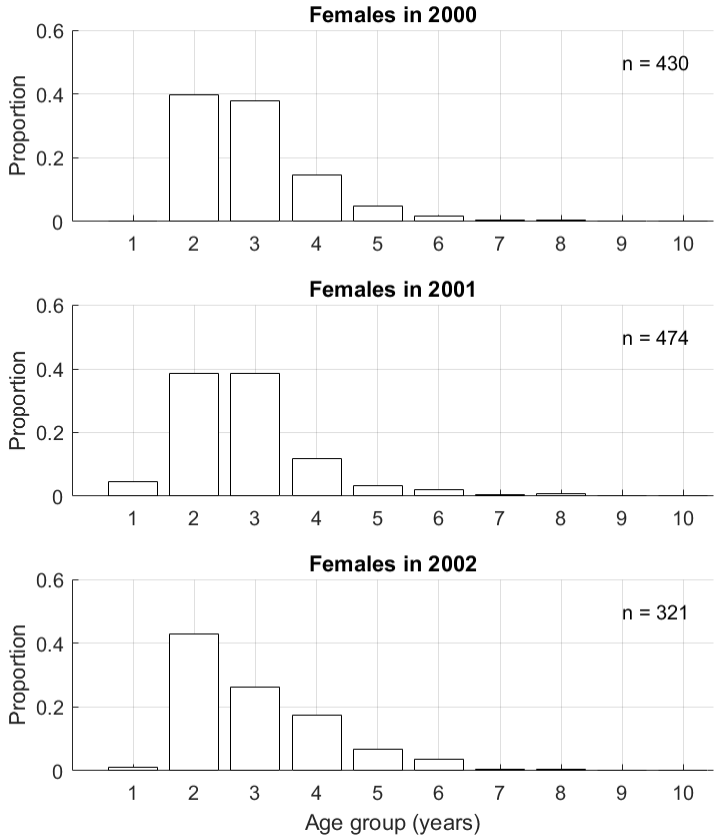
Units = number of fish harvested per boat day

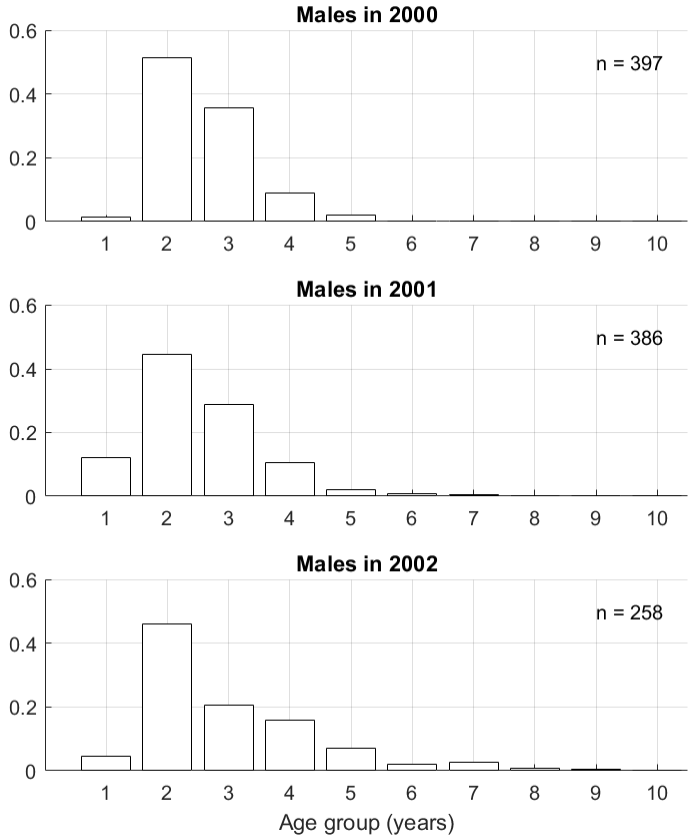


Data need ! – fishing effort

- Consistent daily logbook recording:
  - Identify fishing trips over multiple days
  - Target species and gear
  - Vessels and skippers
  - Locations fished
  - Search and fishing time

Data – fish ages





Data need ! – fish ages

- Need monitoring
- Consistent method
- Spatial coverage

Stock assessment

Data sources → **Traditional (kai kai)**, **Commercial TS and leased**, **Recreational**, **Charter**, **PNG**, **Monitoring**, **Research**

Data inputs → **Total harvests**, **Standardised catch rate**, **Age structure** (**Weight at age**, **Maturity at age**, **Sex ratio at age**, **Fecundity at age**)

Model → **Estimated abundance of fish (this year)** =

Number of fish (last year)
-
Natural mortality
-
Fishing mortality
+
Recruitment
+
Growth

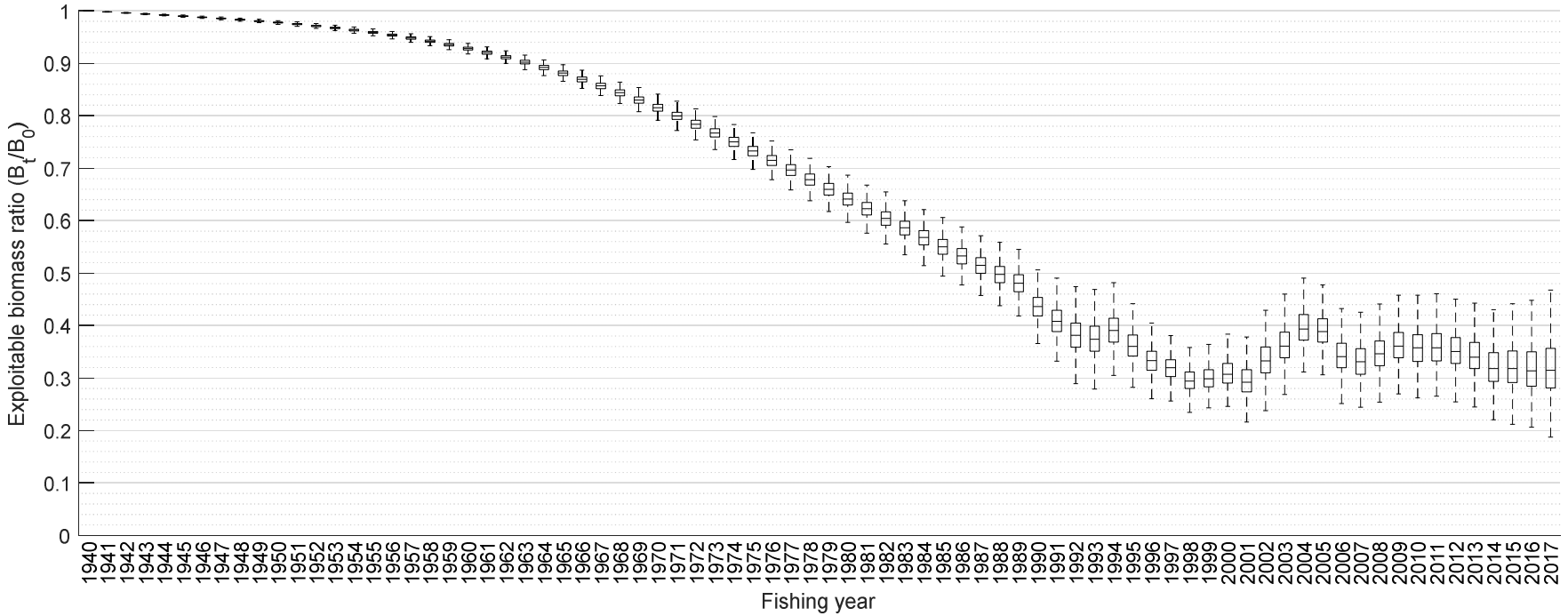
Outputs →

Model estimates:
Historic stock size
Reference points

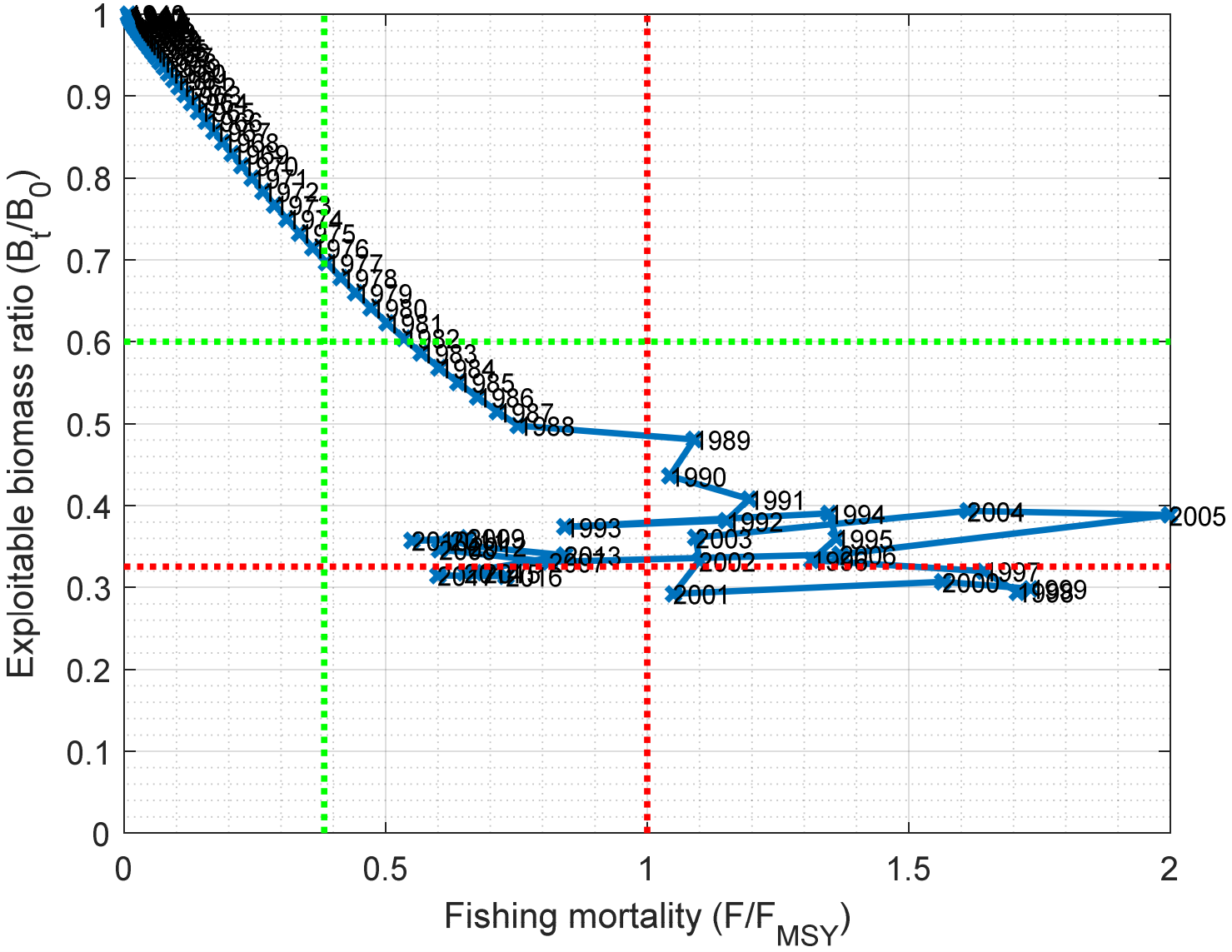
Stock assessment

Analysis	Steepness (*h*)	Natural mortality (*M*)	Age vulnerability	Recruitment variation (std)	Number of parameters
1	0.55 (0.46 : 0.71)	0.3 (Fixed)	Logistic (a50=1.7 a95=2.4)	0.25	32
2	0.69 (0.58 : 0.82)	0.25 (Fixed)	Logistic (a50=1.7 a95=2.3)	0.26	32
3	0.34 (0.26 : 0.53)	0.44 (0.34 : 0.54)	Logistic (a50=1.8 a95=2.5)	0.23	33
4	0.35 (0.23 : 0.49)	0.3 (Fixed)	Domed (a50=1.6, a95=2.2) (Fixed a50d = 5.5, a=0.3)	0.22	32

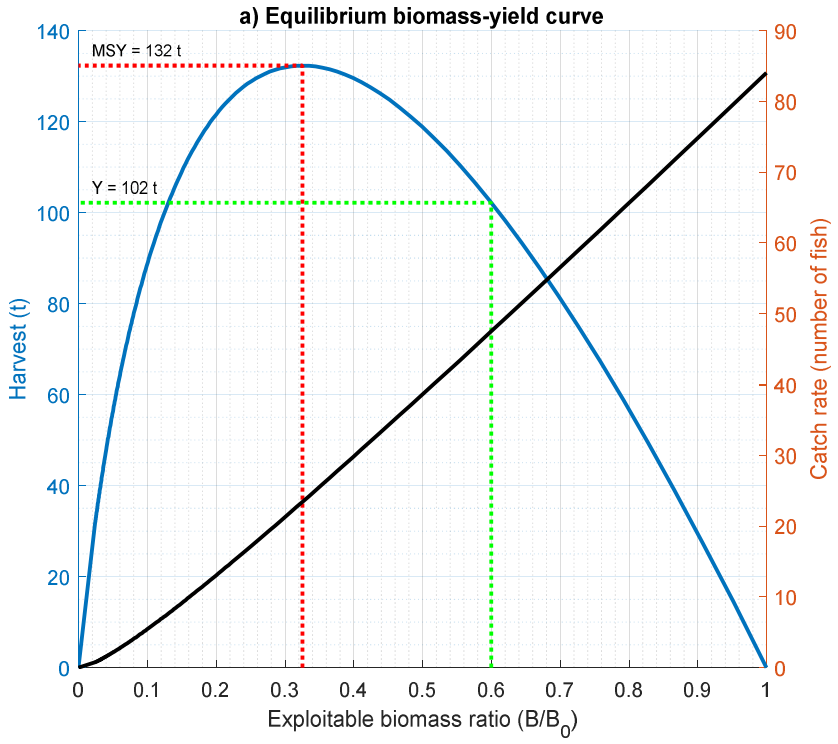
Outputs - Analysis 1

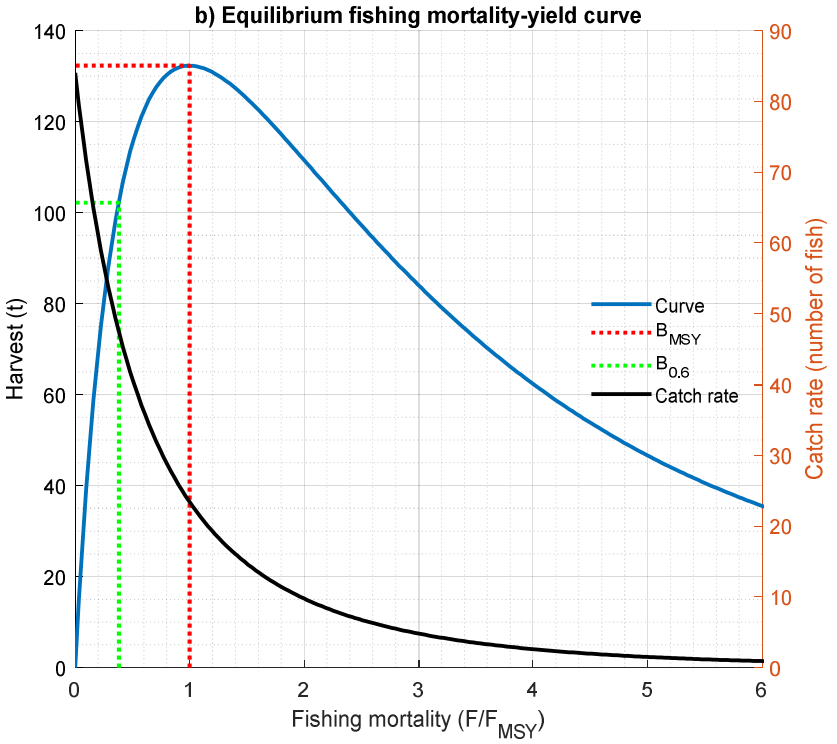


Out puts- Analysis 1 Phase plot

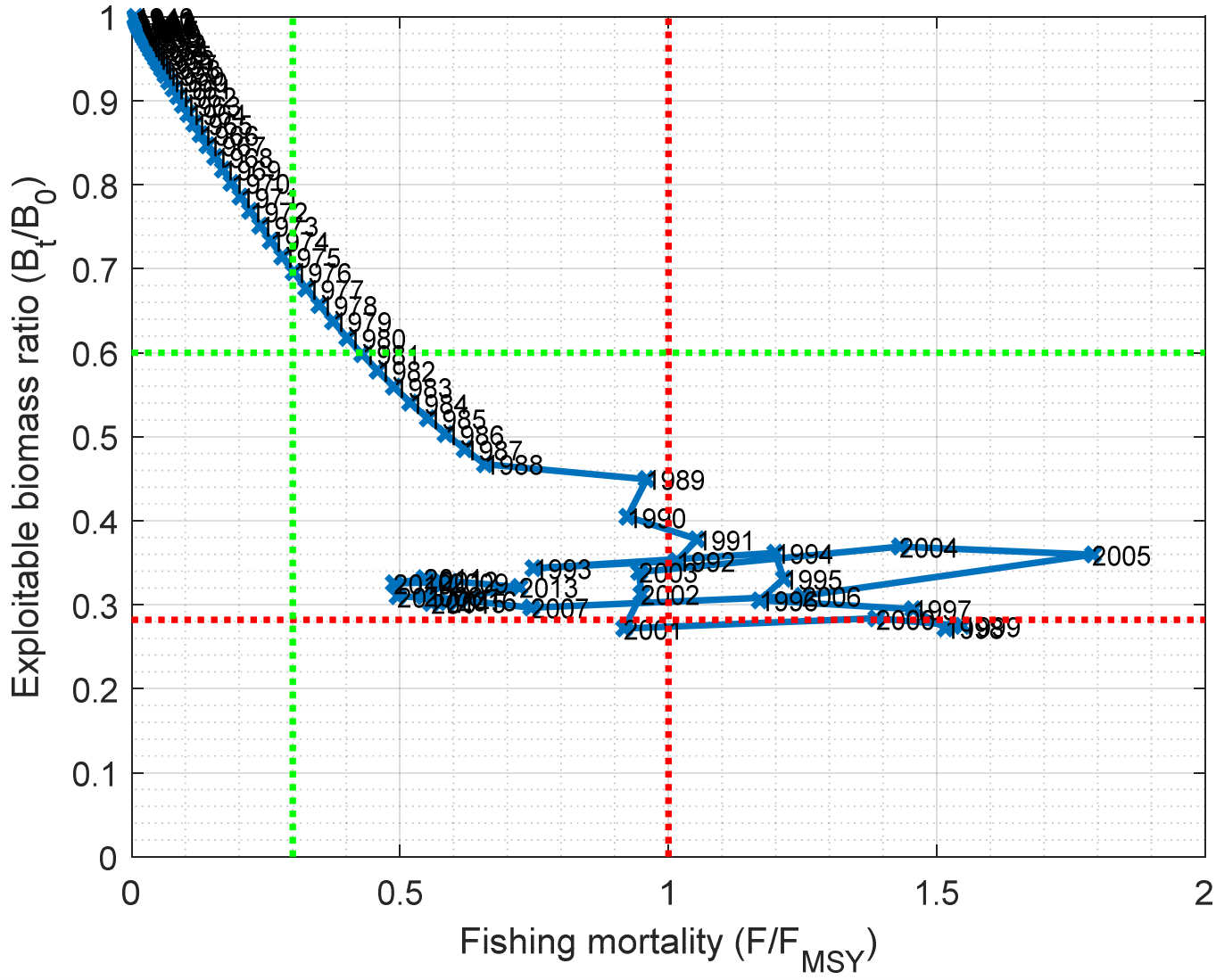


Outputs - Analysis 1

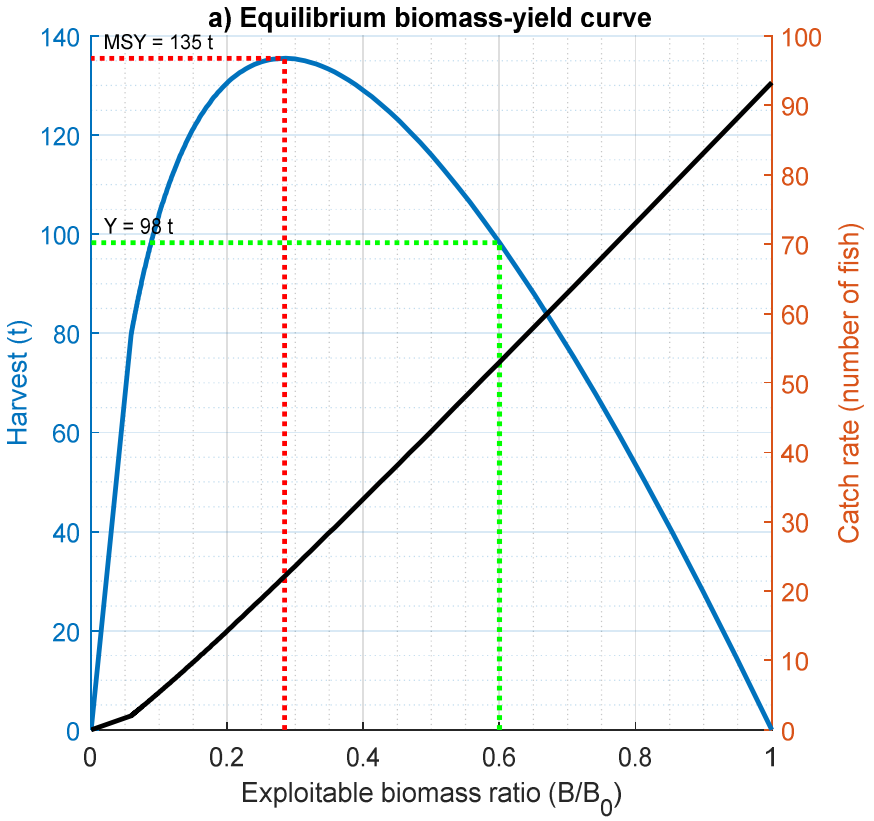


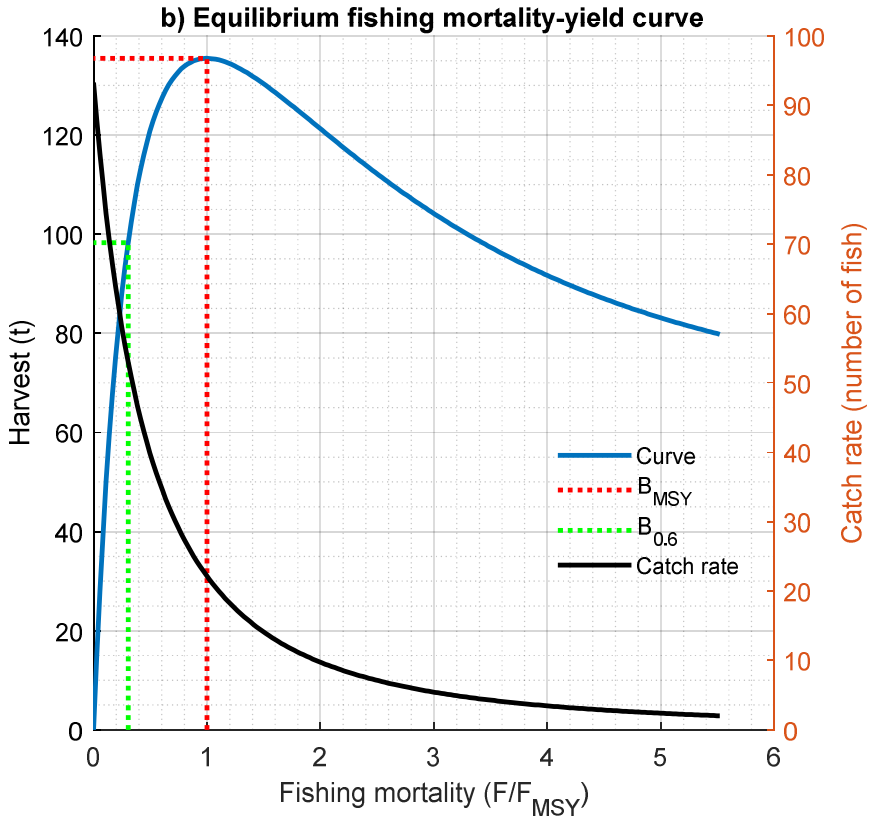


Out puts- Analysis 2 Phase plot

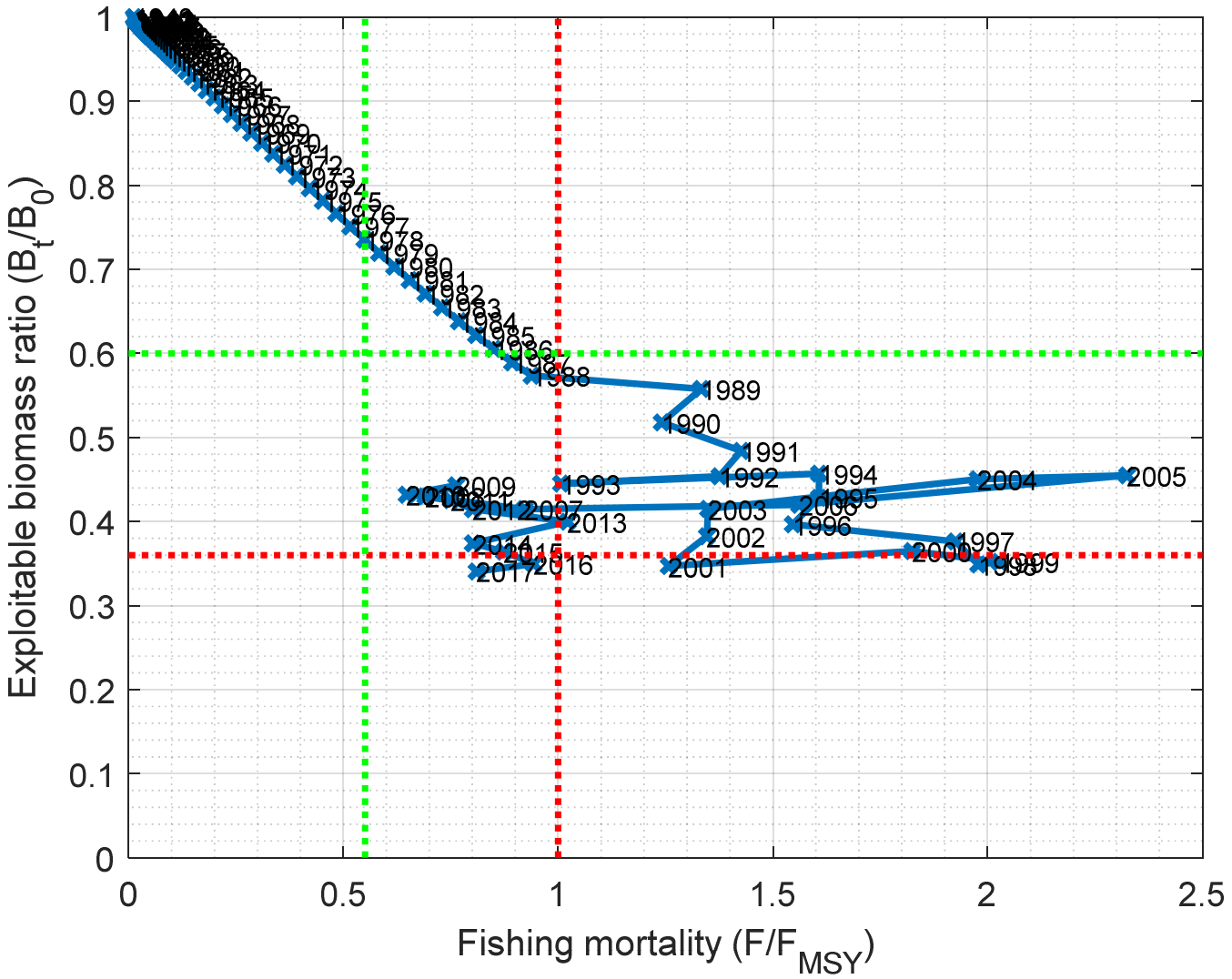


Outputs - Analysis 2

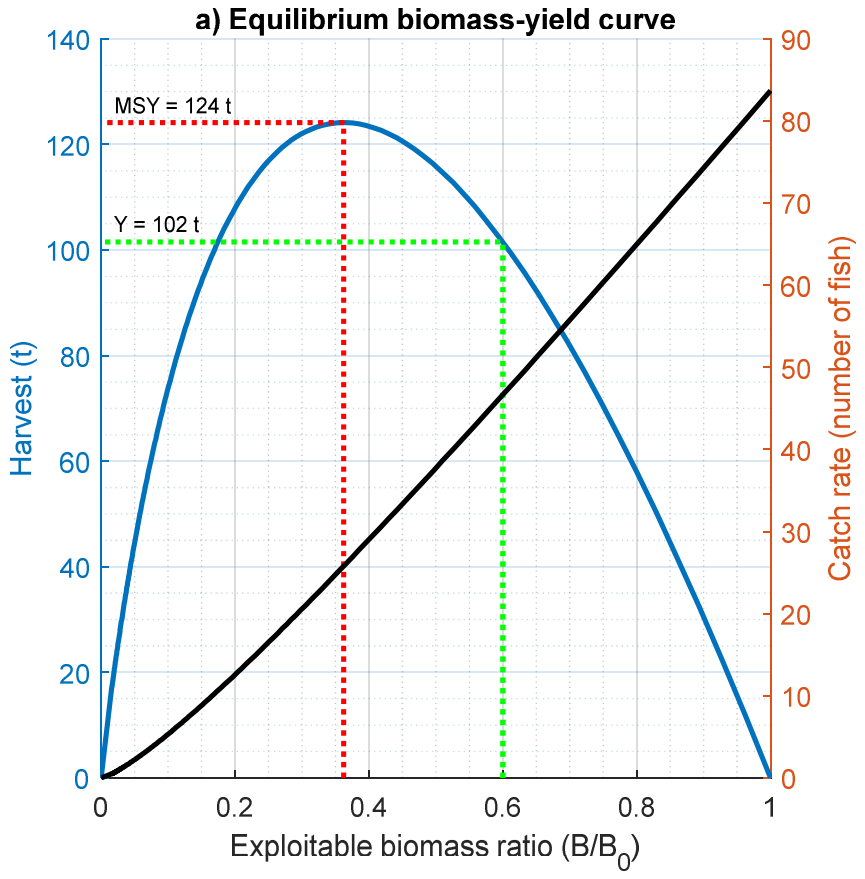


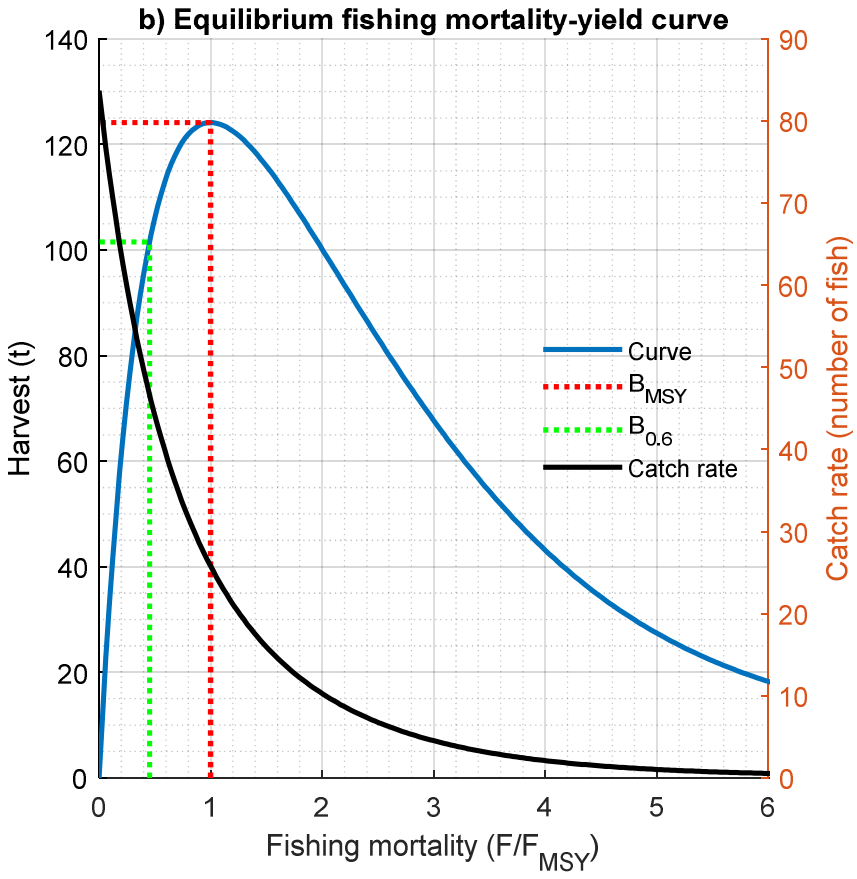


Out puts- Analysis 3 Phase plot

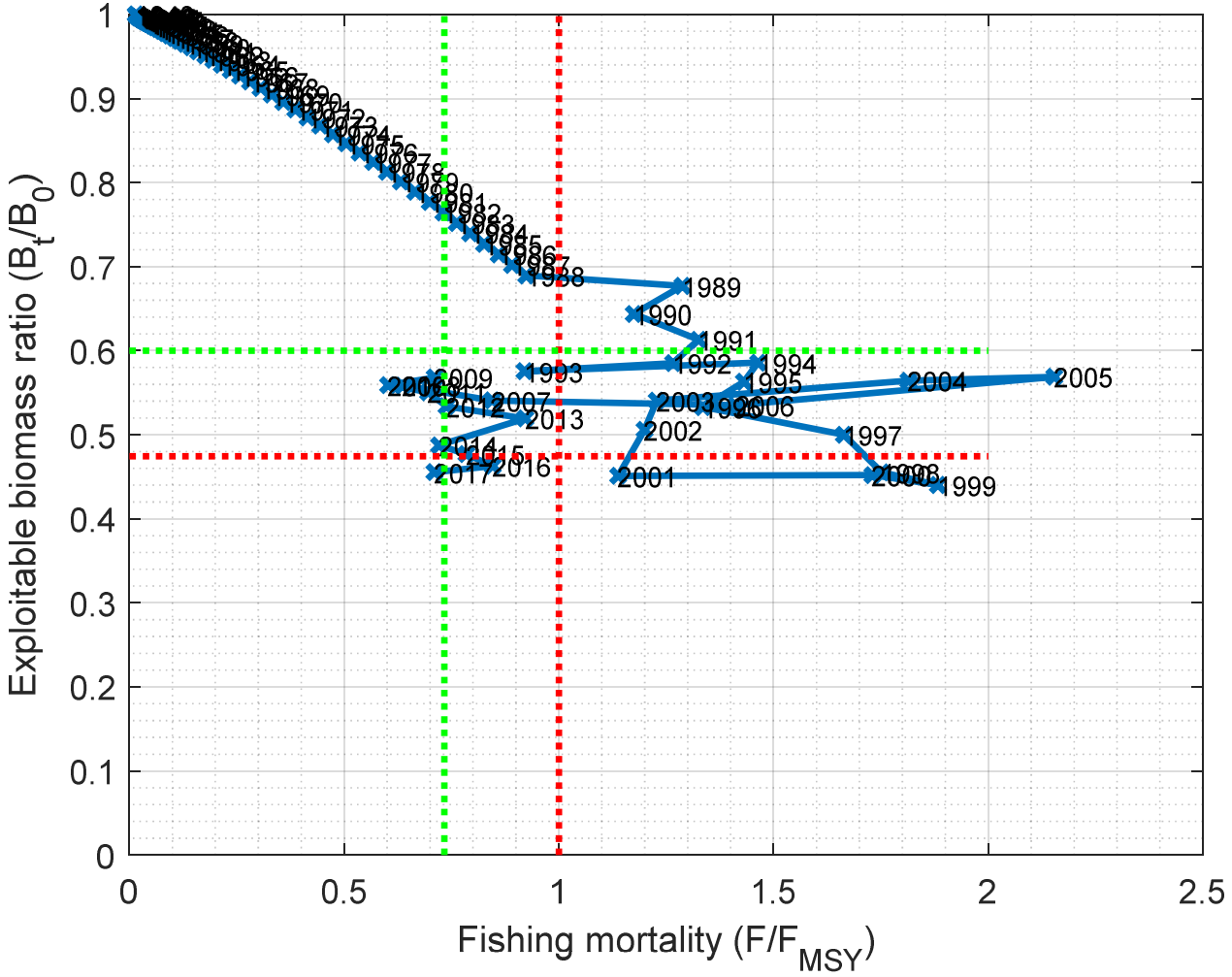


Outputs - Analysis 3

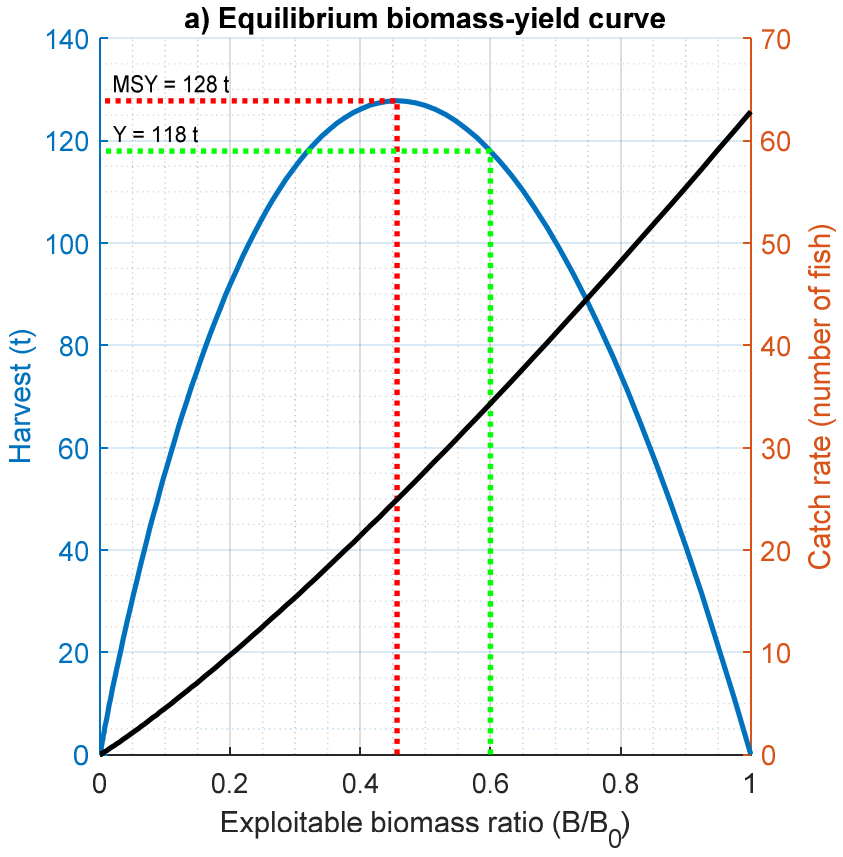


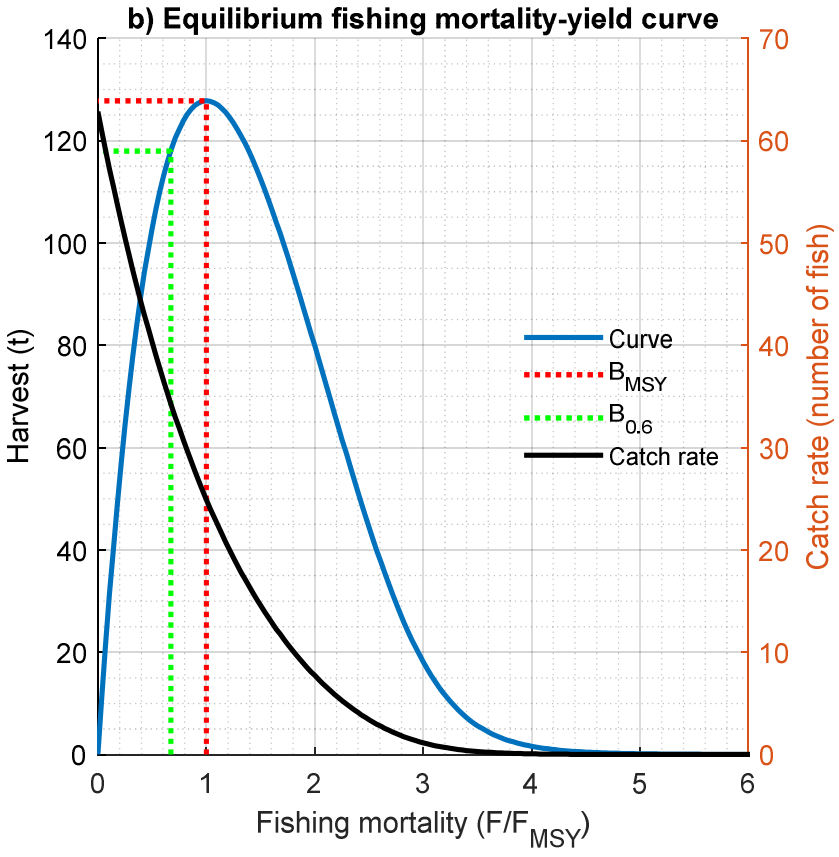


Outputs - Analysis 4



Outputs - Analysis 4





Outputs – median reference points

Biomass status | **Yield tonnes** | **Catch rates - fish**

Analysis	B_{2017}/B_0	F_{MSY} @ B_{MSY}	F_{MSY} @ B_{2017}	F_{B60} @ B_{60}	F_{B60} @ B_{2017}	CPUE @B_{MSY}	CPUE @B_{60}	CPUE @B_{20}
1 (M=0.3)	0.31 (0.24 : 0.46)	136 (125 : 161)	129 (90 : 278)	105 (99 : 115)	55 (40 : 88)	22 (13 : 26)	44 (35 : 53)	12 (9 : 14)
2 (M=0.25)	0.31 (0.23 : 0.45)	140 (130 : 160)	152 (100 : 296)	102 (96 : 110)	53 (37 : 82)	20 (12 : 25)	48 (39 : 58)	13 (10 : 16)
3 (M=0.44)	0.34 (0.26 : 0.53)	121 (94 : 155)	104 (86 : 126)	100 (66 : 230)	58 (42 : 113)	23 (15 : 27)	36 (27 : 45)	11 (8 : 13)
4 (large error)	0.46 (0.35 : 0.77)	121 (80 : 207)	113 (74 : 335)	114 (73 : 190)	84 (53 : 233)	21 (13 : 25)	27 (17 : 33)	8 (5 : 10)

(95% confidence intervals)

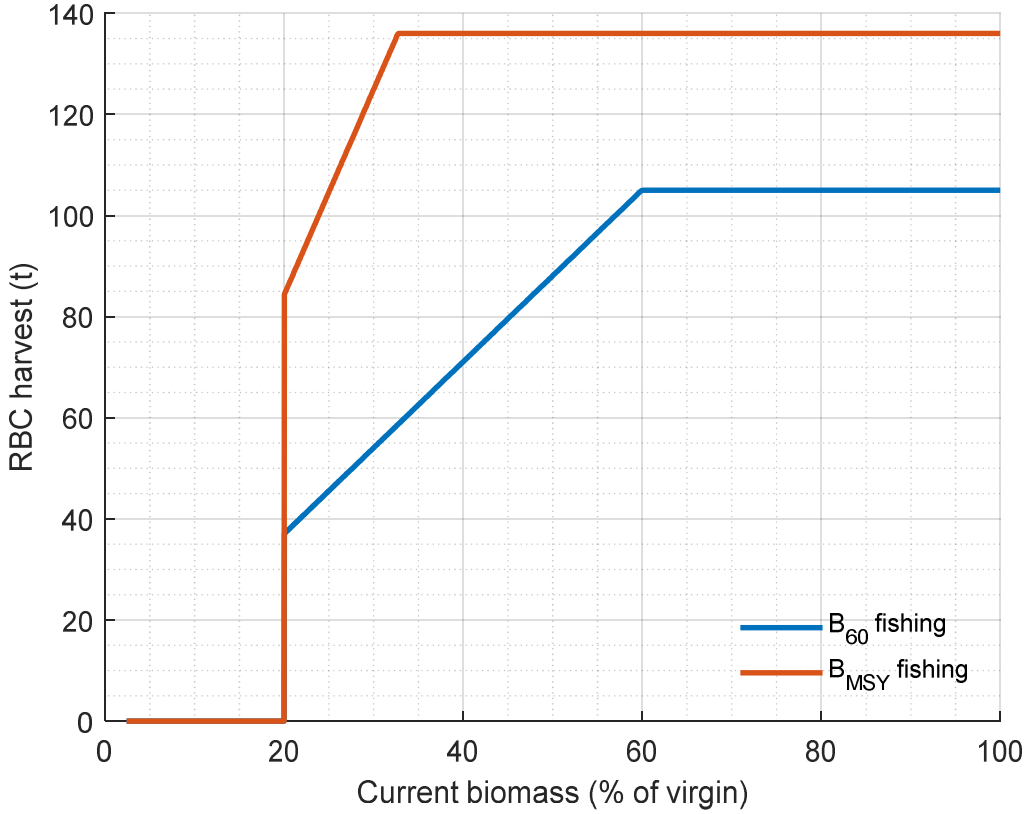
Key elements of a harvest strategy

- Operational **objectives**
- **Indicators** of fishery performance
- **Reference points** for indicators
- Program to collect **data**
- **Method** to analyse data - stock assessment
- **Rules** to use results and set levels of fishing
- Keep **simple**

Harvest control rule

- Model based example with hockey stick

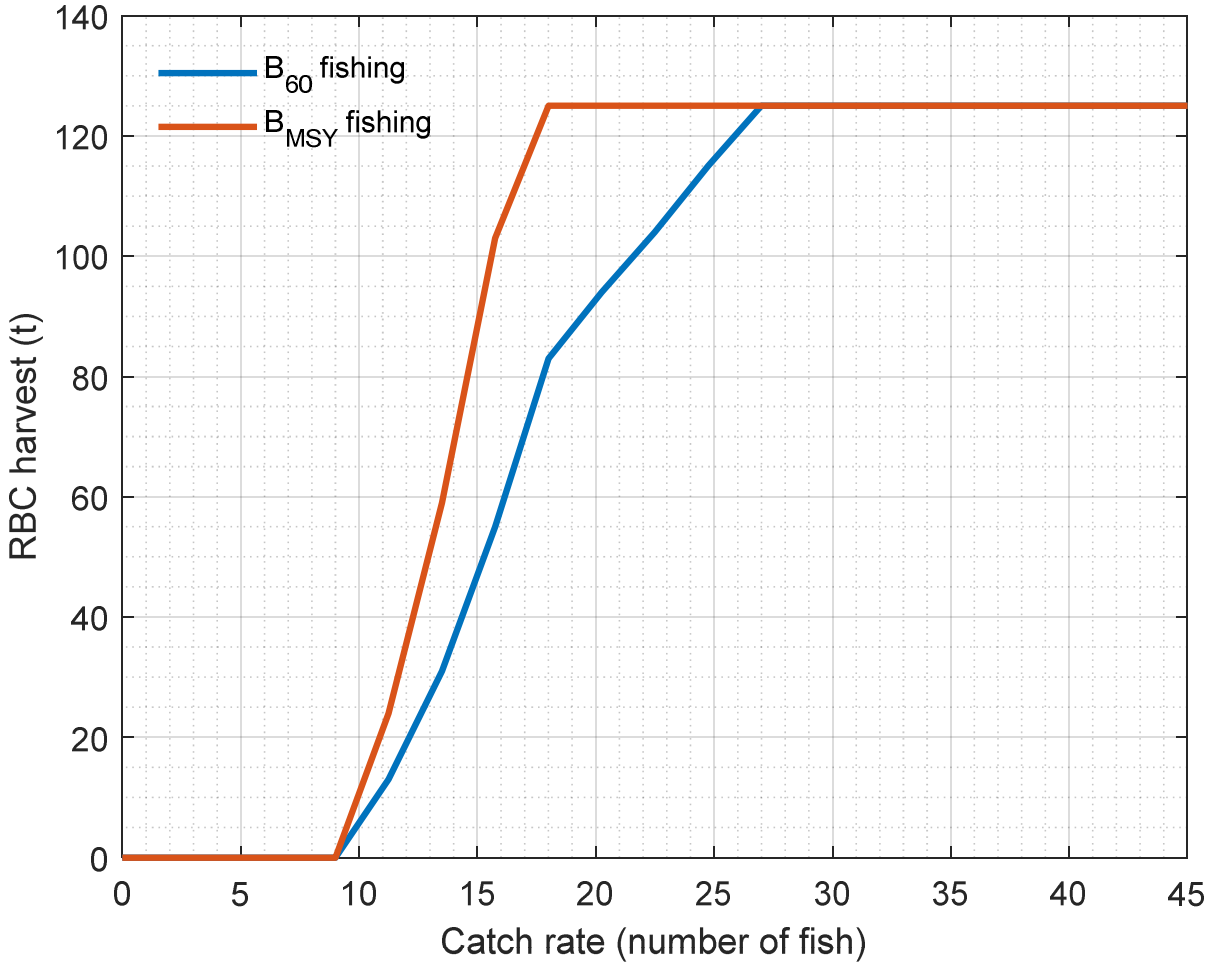
  RBC = Exploitable biomass x Target harvest rate



Harvest control rule

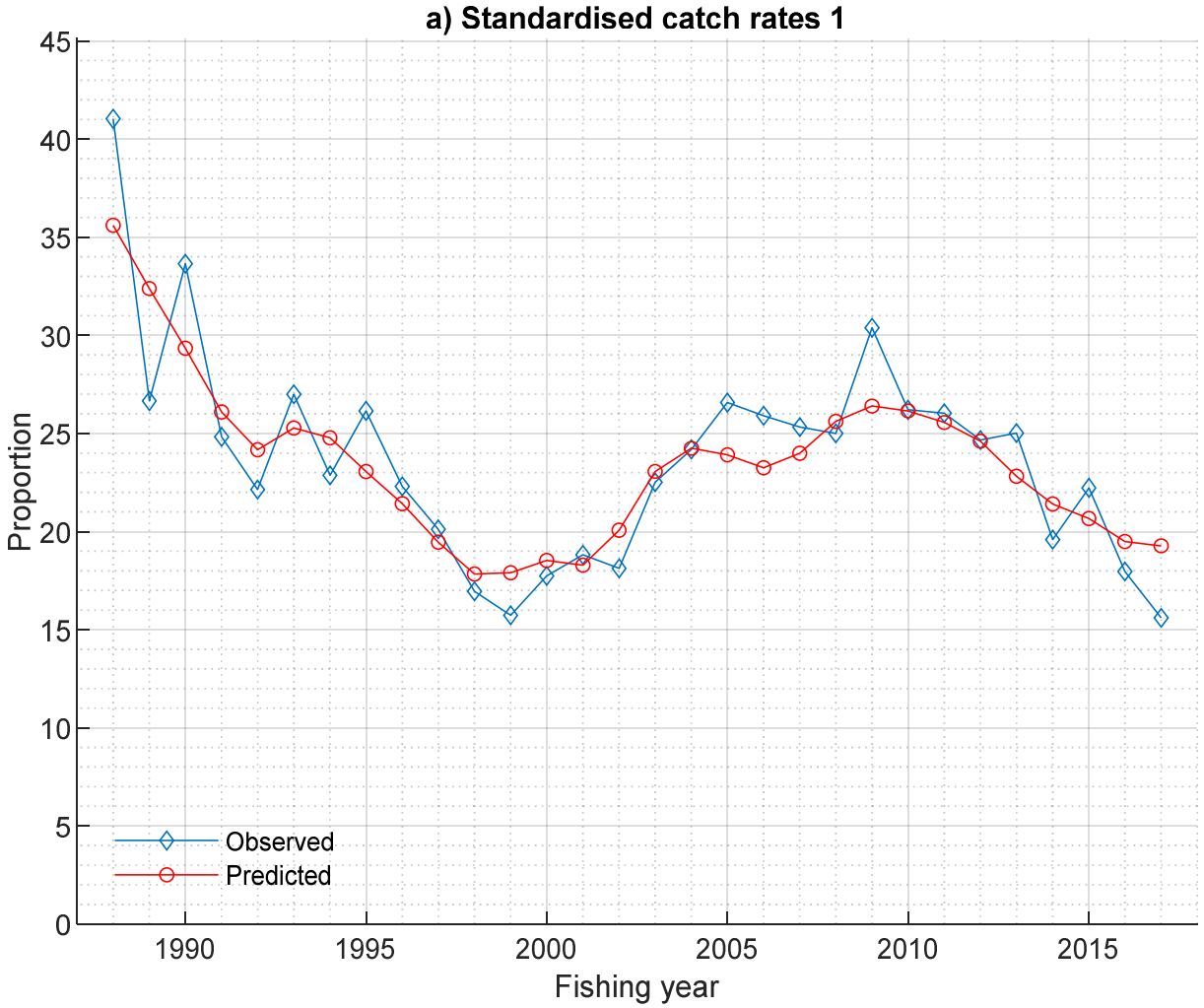
- Data based example using hockey stick

Minimum(MaxRBC **x** Rel.Catch.Rate **x** Adjustment (%), MaxRBC)

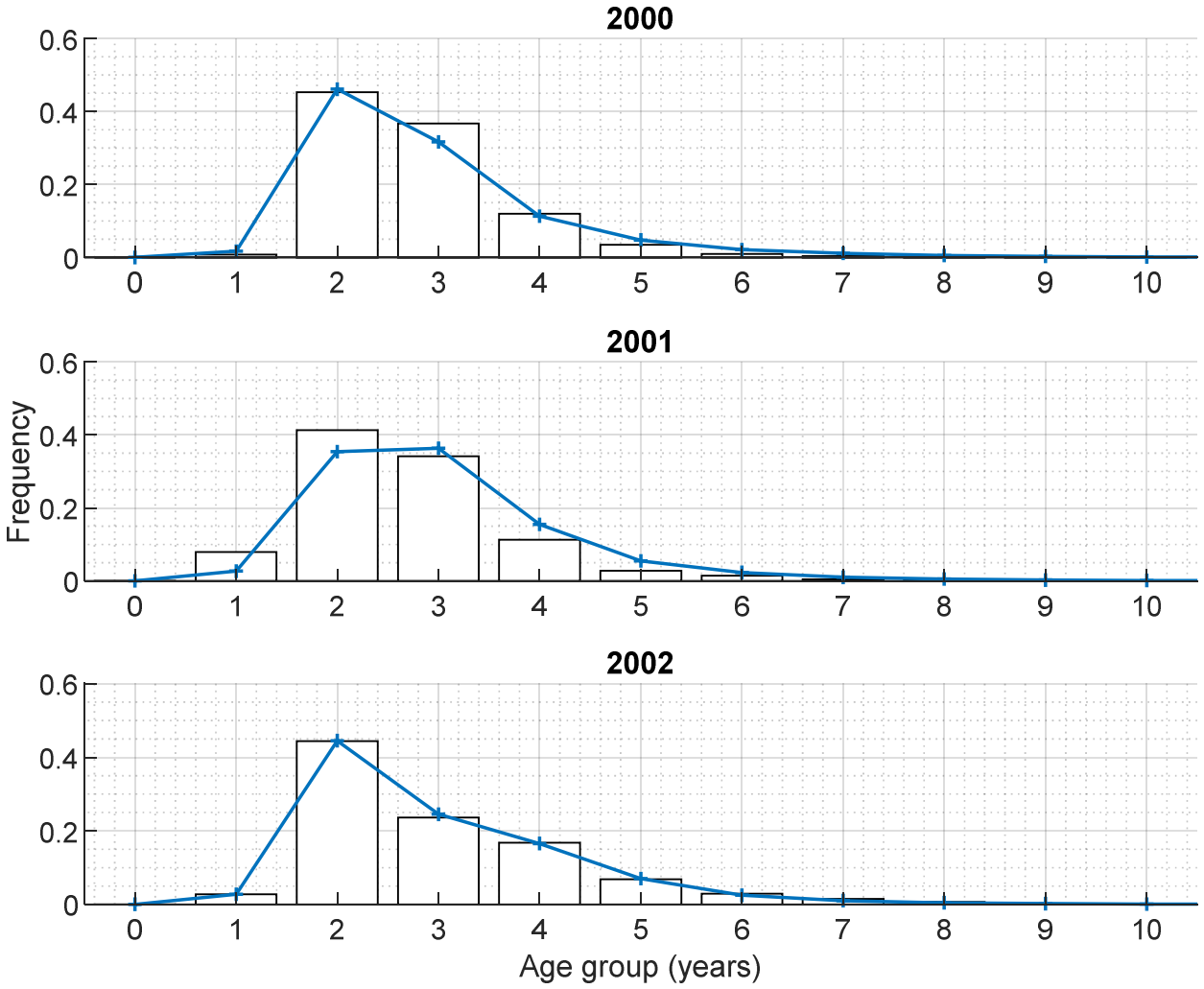


MaxRBC = 125t
TargCPUE = 27 fish

GOF – catch rates



GOF – Fish age frequency



Harvest control rule

- Example hockey stick rule