Assessment of orange roughy stocks within SIOFA statistical areas 1, 2, 3a, and 3b

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March 2018

Acknowledgements

- Thanks to the Cook Islands delegation for the nomination to do this work and the SIOFA Secretariat for organizing the contract

- Thanks to Graham Patchell for his years of dedicated data collection and analysis that has made these assessments possible

- Thanks to NIWA for the use of their excellent stock assessment package CASAL

Presentation structure

- Introduction
- Methods
  - Stock hypotheses
  - Data
  - Models
  - NZ's Harvest Control Rule (HCR)
- Results
  - Catch-history based method
 - Bayesian MPD estimates

Introduction

- Full Bayesian assessment for Walter's Shoal Region (WSR) already presented

- Now looking at assessments for other stocks (geographical groupings as defined by Graham Patchell) in the SIOFA areas 1, 2, 3a, 3b

- Seven stocks but "Western Walters" has almost no catch and no acoustic estimates – so no assessment attempted

- Six stocks assessed using a catch-history based method

- Three of those six have acoustic estimates and are also assessed with a simple CASAL model and MPD estimates (and borrowing from the WSR assessment)

Methods: stock hypotheses
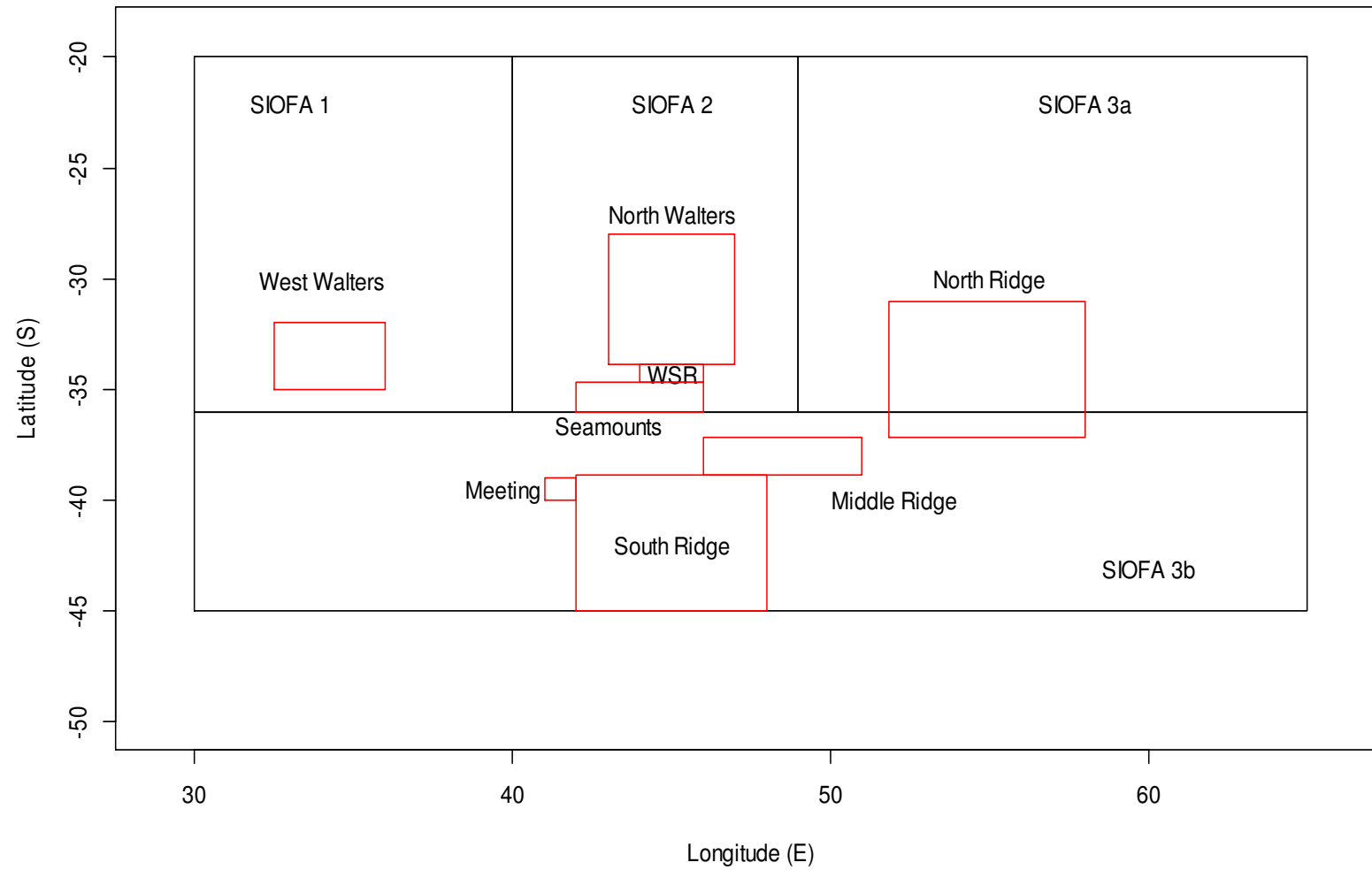
Methods: data: catch histories
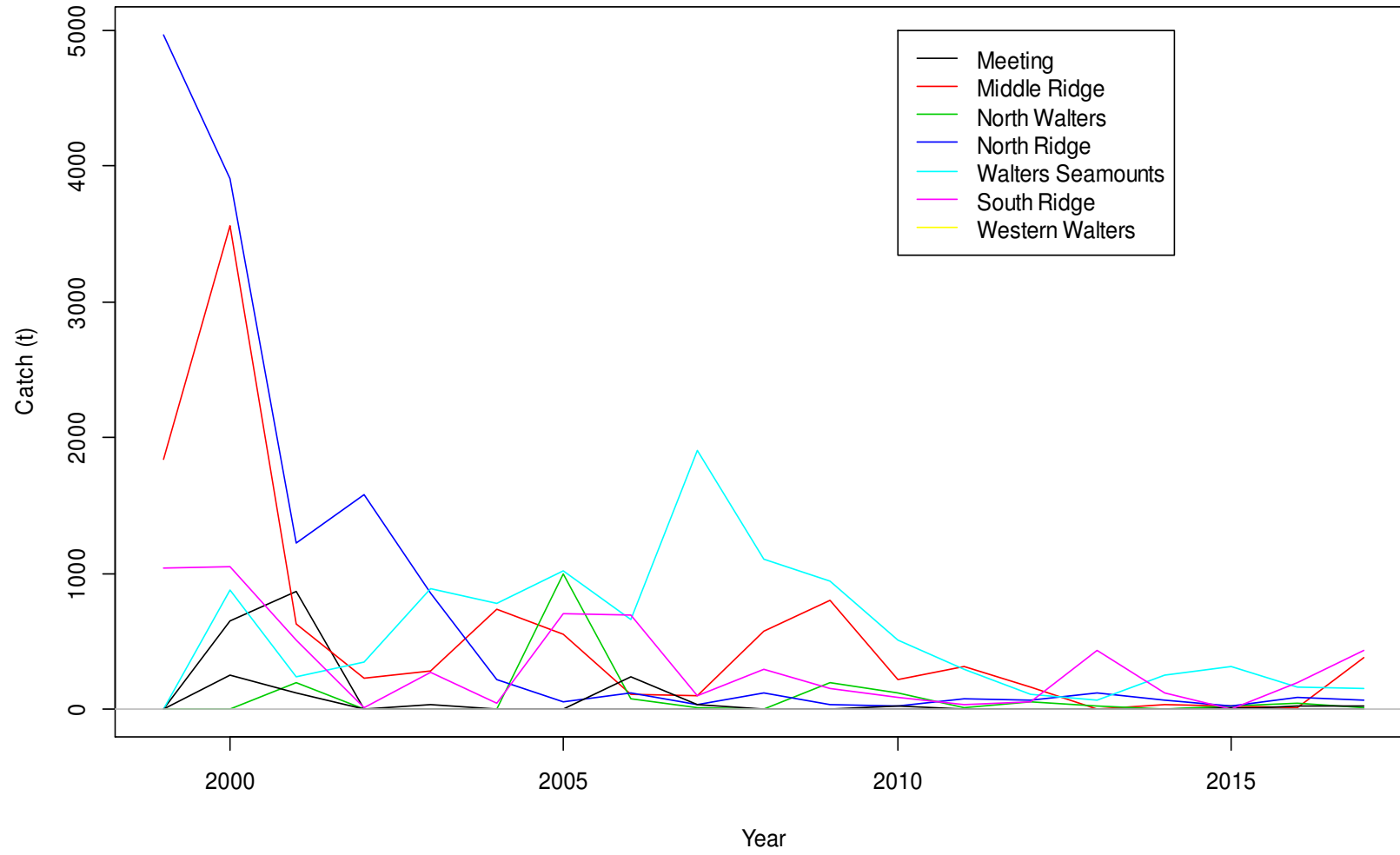
Methods: data: acoustic biomass estimates

- None of the acoustic survey estimates for these areas have been reviewed or revised or refined
- However, estimates from surveys over "large" areas (e.g., more than 20 sq. n.m.) were ignored because of potential double counting issues
- And surveys with very large CVs were ignored (e.g., 60%)
- All surveys were noted to be at "peak spawning"
- Revised estimates (where double counting was not an issue) have **not** been hugely different (a couple higher and a couple lower)

Acoustic estimates: Walters Seamounts

Feature	Year	Low estimate (t)	Middle estimate (t)	High estimate (t)	CV (%)
1	2009	240	**381**	629	55
	2010	847	**1345**	2219	35
2	2010	2099	**3331**	5496	18
3	2009	6070	**9635**	15 898	16

Largest catch: 1907 t   (2007)
Total catch: 10 636 t

Acoustic estimates: North Walters

Feature	Year	Low estimate (t)	Middle estimate (t)	High estimate (t)	CV (%)
1	2009	3050	**4841**	7988	36
2	2009	1976	**3136**	5174	30

Largest catch: 995 t (2005)
Total catch: 1784 t

Acoustic estimates: Middle Ridge

| Feature	Year	Low estimate (t)	Middle estimate (t)	High estimate (t)	CV (%)
1	2004	5332	**8463**	13 964	58
2	2004	4342	**6892**	11 372	26
	2008	1544	**2451**	4044	37
3	2004	5866	**9311**	15 363	57
4	2009	4362	**6924**	11 425	30
	2011	9850	**15 635**	25 798	34
5	2008	2003	**3179**	5245	25

Largest catch: 3563 t   (2000)
Total catch: 10 568 t

Methods: models (1)

- Catch-history based method:
  - Single area, single sex, ages (1-120$^+$), keeping track of maturity (immature, mature categories)
  - Fishery at the end of the year on spawning fish
  - Length-weight, growth from Sleeping Beauty (results insensitive to these parameters)
  - M=0.045, Beverton-Holt, h=0.75
  - Maturity from WSR middle assessment
  - Three different maximum exploitation rates: 50%, 20%, 10%
  - Calculate the B_0s which satisfy each maximum exploitation rate (just a manual search running the model at different B_0s and looking at the annual exploitation rates)

Example of B$_0$ calculations (Meeting)
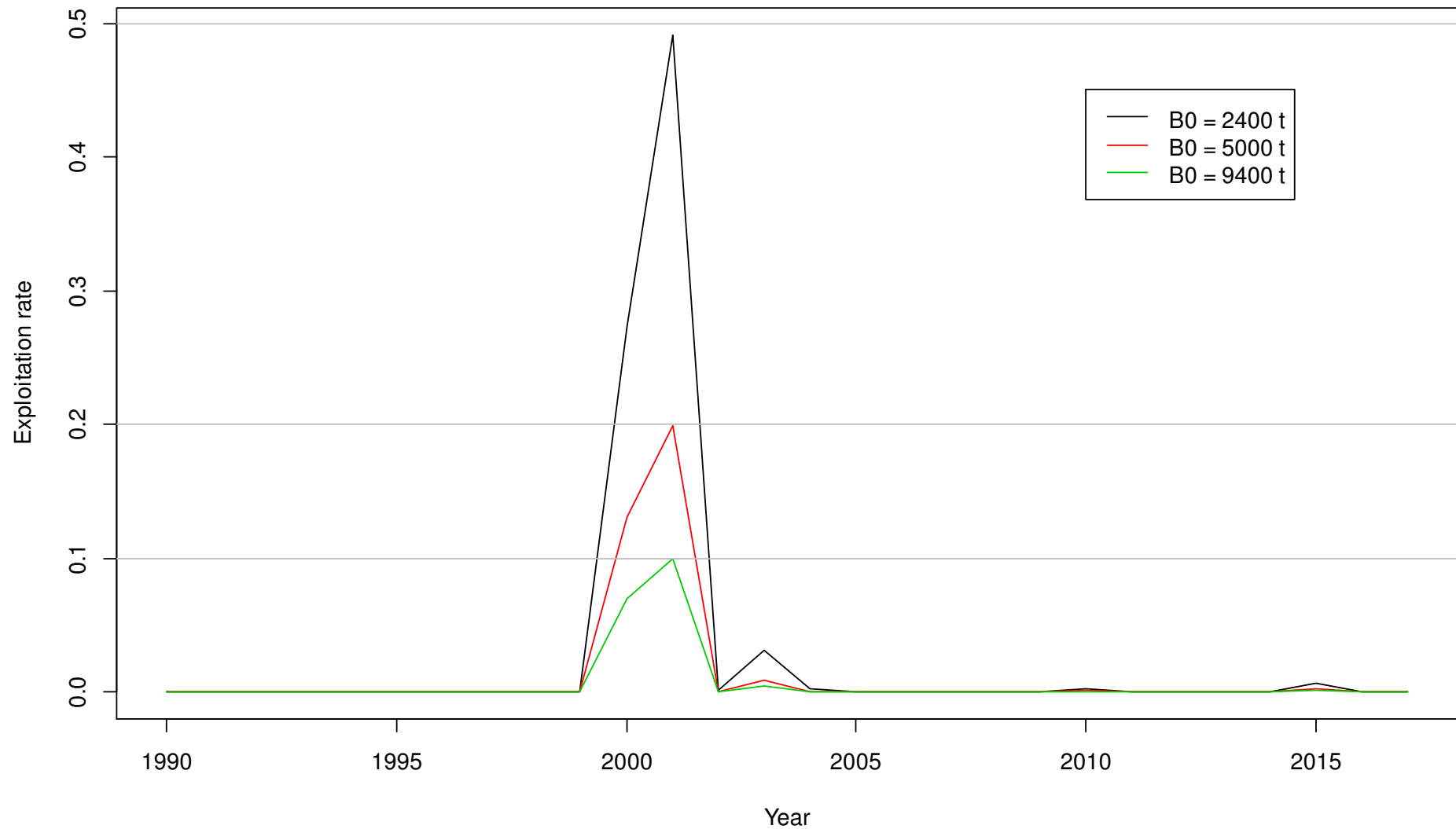
Methods: models (2)

- Bayesian MPD estimates:
  - Single sex, ages (1-120$^+$), keeping track of maturity
  - Fishery at the end of the year on spawning fish
  - Migration model (two stocks), single area (one stock)
  - Length-weight, growth from Sleeping Beauty (results insensitive to these parameters)
  - M=0.045, Beverton-Holt, h=0.75
  - Three different treatments of the acoustic estimates: Low, Middle, High
  - Use the WSR estimates for maturity (Low, Middle, High)
  - Use the WSR posteriors of the acoustic q as informed priors for the acoustic q (Low, Middle, and High)

WSR results used in MPD models

		Acoustic q		Maturation	
	Mean	CV (%)	a_{50}	a_{to95}	
Low	0.59	18	37	13	
Middle	0.70	22	37	14	
High	0.76	21	36	13	

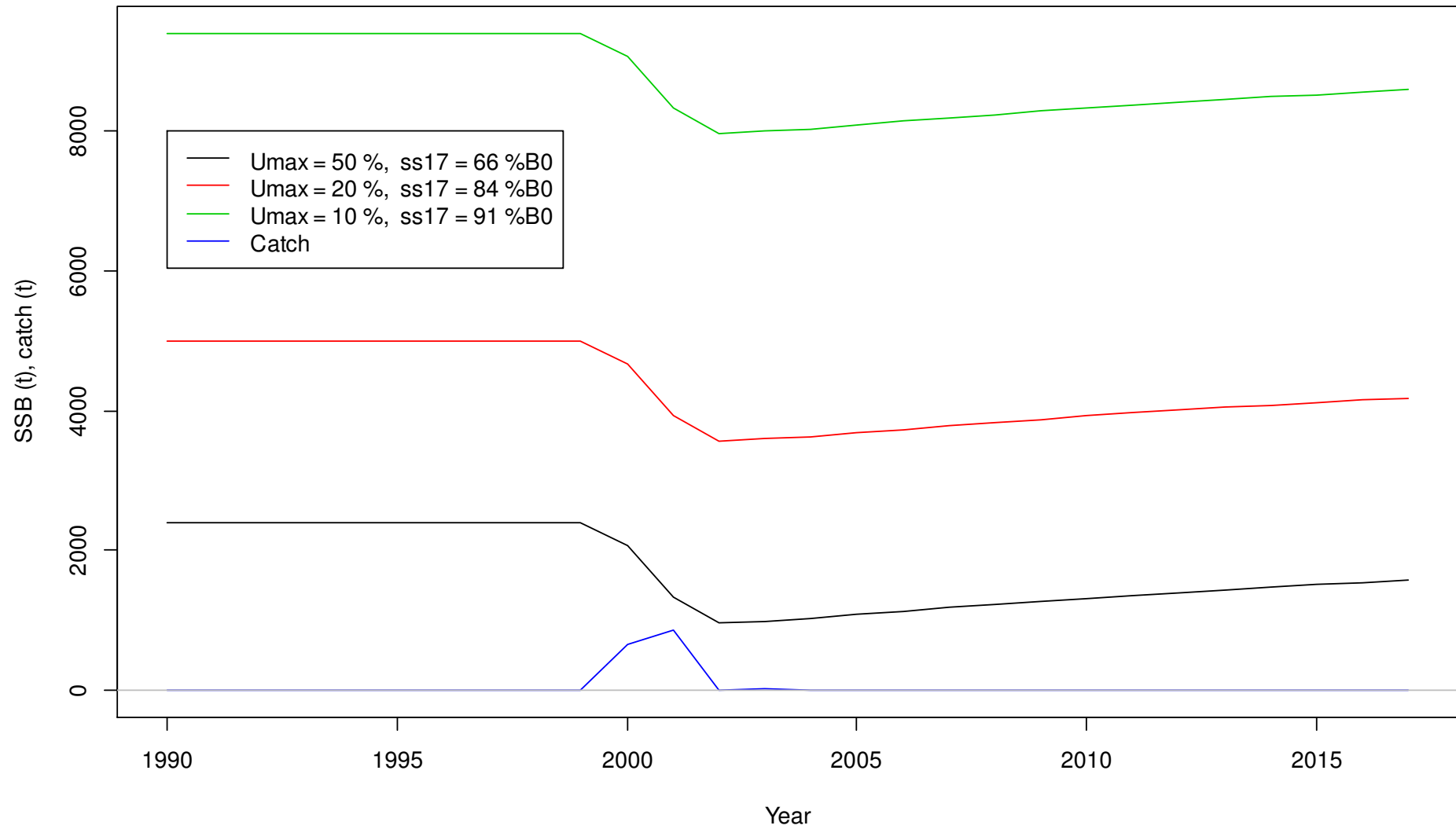# NZ's orange roughy Harvest Control Rule
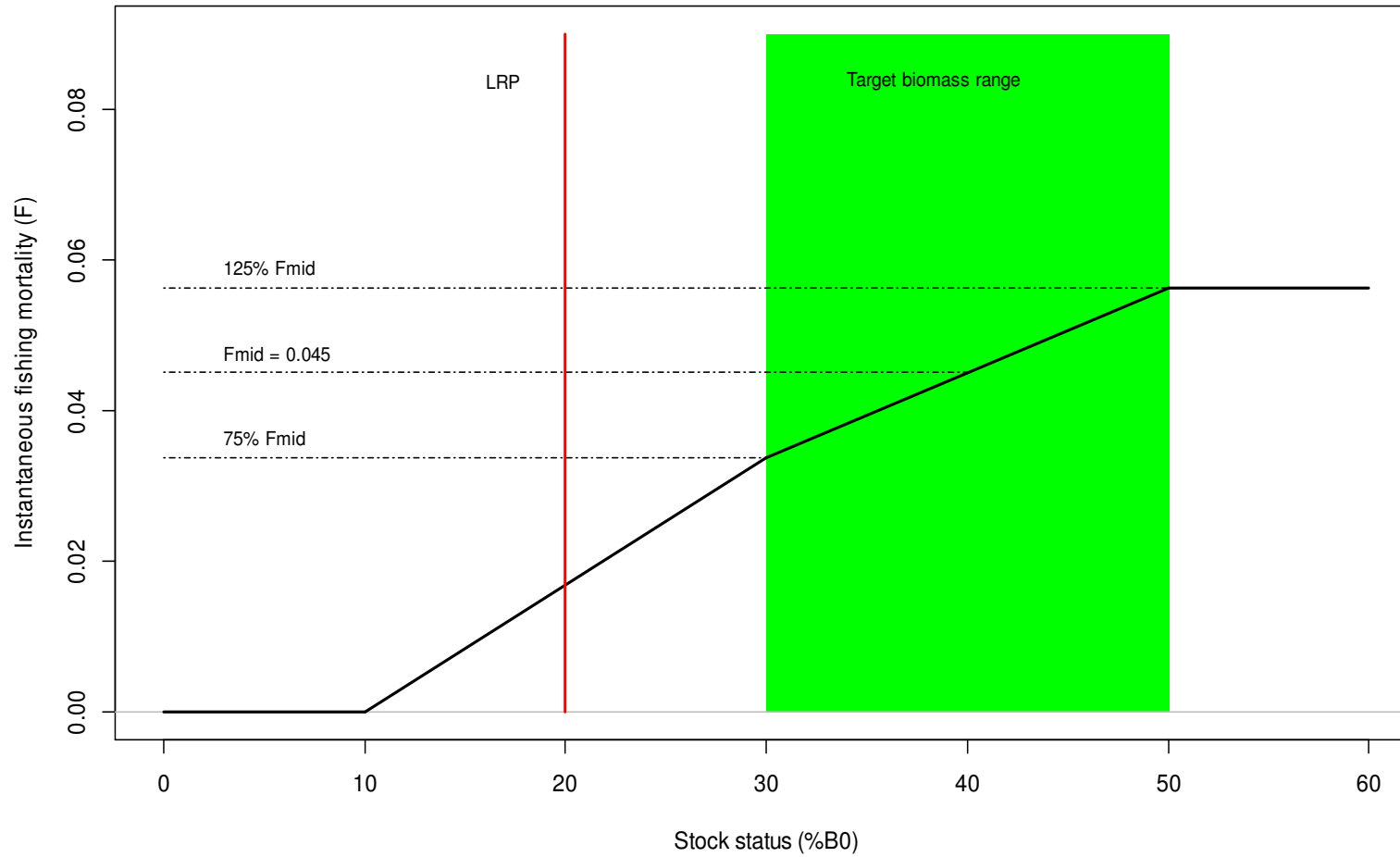
Results

- Catch history based method: for each of 3 maximum exploitation rate:
  - B_0, B_{17} and hence current stock status (B_{17}/B_0)
  - Current stock status feeds into the HCR to give U_{HCR}
  - $U_{HCR} \times B_{beg18}$ = catch limit
- MPD estimates: for each of 3 treatments of the acoustic estimates:
  - As above to get a catch limit based on the MPD estimate of B_0, $B_{17,}$ stock status, B_{beg18}
- Comparison of the two sets of results for the three stocks with acoustic estimates
- A look at the WSR MPD estimates and catch-history based estimates (in comparison with the Bayesian MCMC estimates)
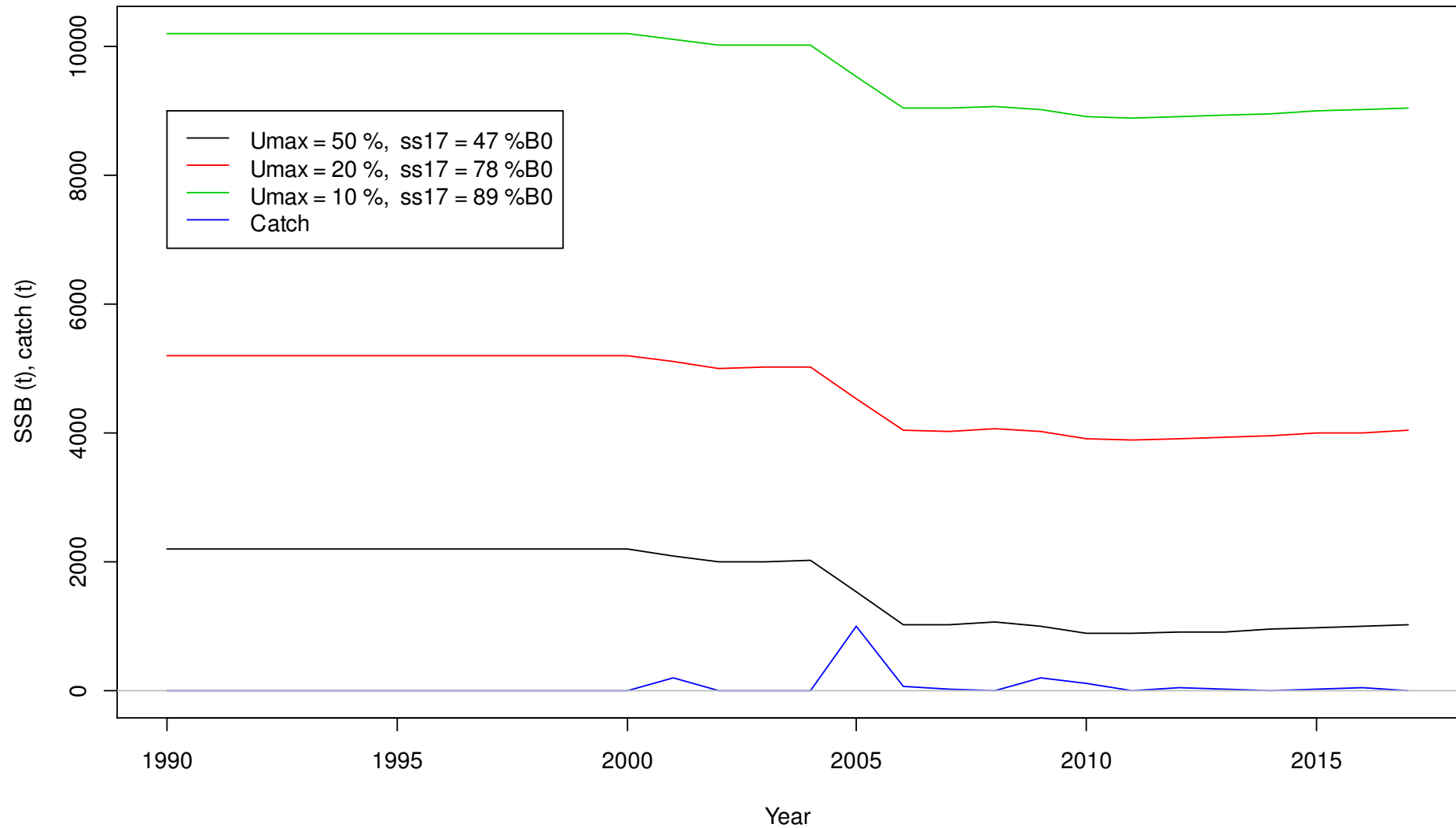
Results: catch-history based method

		B_0 (000 t)	B_{17} (000 t)	B_{beg18} (000t)	ss_{17} (%B_0)	U_{HCR} (%)	Catch (t)
Meeting	U_{max} = 50%	2.4	1.6	1.6	66	5.625	90
	U_{max} = 20%	5.0	4.2	4.2	84	5.625	240
	U_{max} = 10%	9.4	8.6	8.6	91	5.625	480
N. Walters	U_{max} = 50%	2.2	1.0	1.1	47	5.625	60
	U_{max} = 20%	5.2	4.0	4.1	78	5.625	230
	U_{max} = 10%	10.2	9.0	9.1	89	5.625	510
Seamounts	U_{max} = 50%	8.6	1.5	1.7	17	1.240	20
	U_{max} = 20%	14.0	6.9	7.1	50	5.574	400
	U_{max} = 10%	24.0	17.0	17.2	71	5.625	970
N. Ridge	U_{max} = 50%	13.0	5.8	6.1	45	5.020	300
	U_{max} = 20%	24.0	16.9	17.1	70	5.625	960
	U_{max} = 10%	50.0	43.0	43.1	86	5.625	2420
M. Ridge	U_{max} = 50%	8.9	2.8	2.9	32	3.600	100
	U_{max} = 20%	20.0	14.0	14.1	70	5.625	790
	U_{max} = 10%	38.0	32.0	32.1	84	5.625	1800
S. Ridge	U_{max} = 50%	4.5	0.7	0.6	15	0.800	5
	U_{max} = 20%	7.0	3.2	3.1	46	5.130	160
	U_{max} = 10%	11.5	7.7	7.6	67	5.625	430

Catch-history based: Meeting

Catch-history based: North Walters

Legend:
- Umax = 50 %, ss17 = 47 %B0
- Umax = 20 %, ss17 = 78 %B0
- Umax = 10 %, ss17 = 89 %B0
- Catch

Y-axis: SSB (t), catch (t)
X-axis: Year

Catch-history based: Seamounts
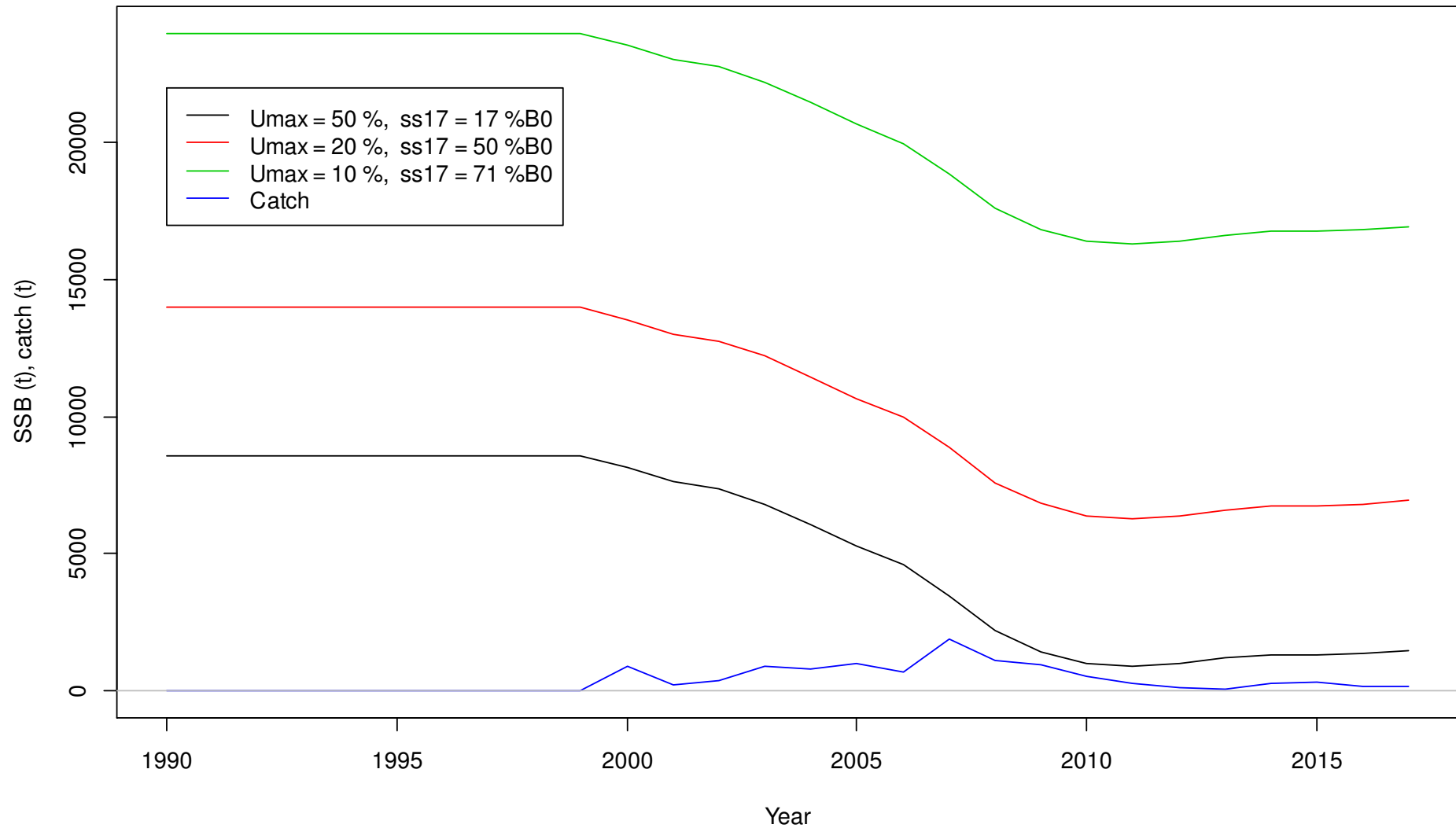
Catch-history based: North Ridge
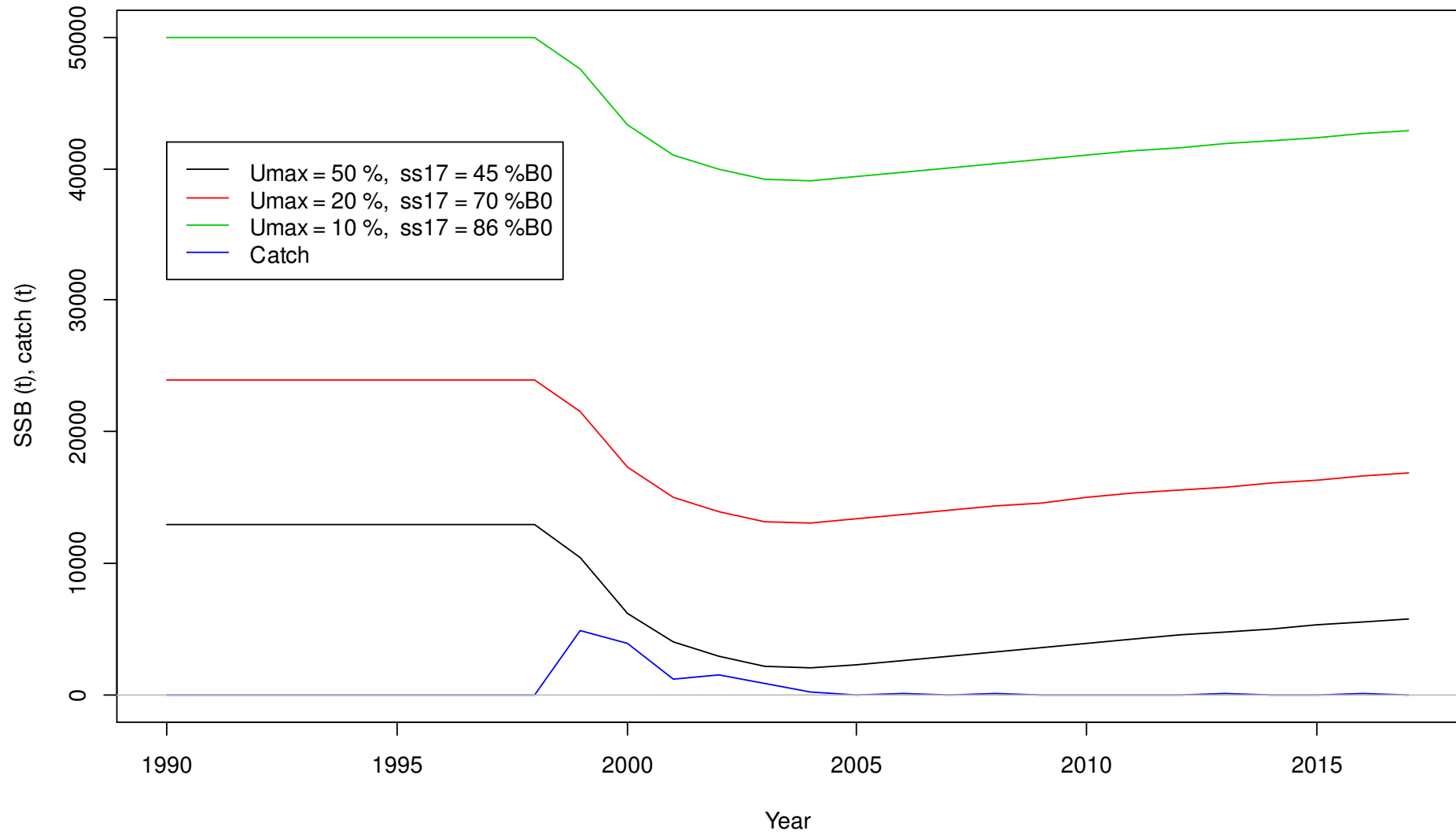
Catch-history based: Middle Ridge

Legend:
- Umax = 50 %, ss17 = 32 %B0
- Umax = 20 %, ss17 = 70 %B0
- Umax = 10 %, ss17 = 84 %B0
- Catch

Y-axis: SSB (t), catch (t)
X-axis: Year
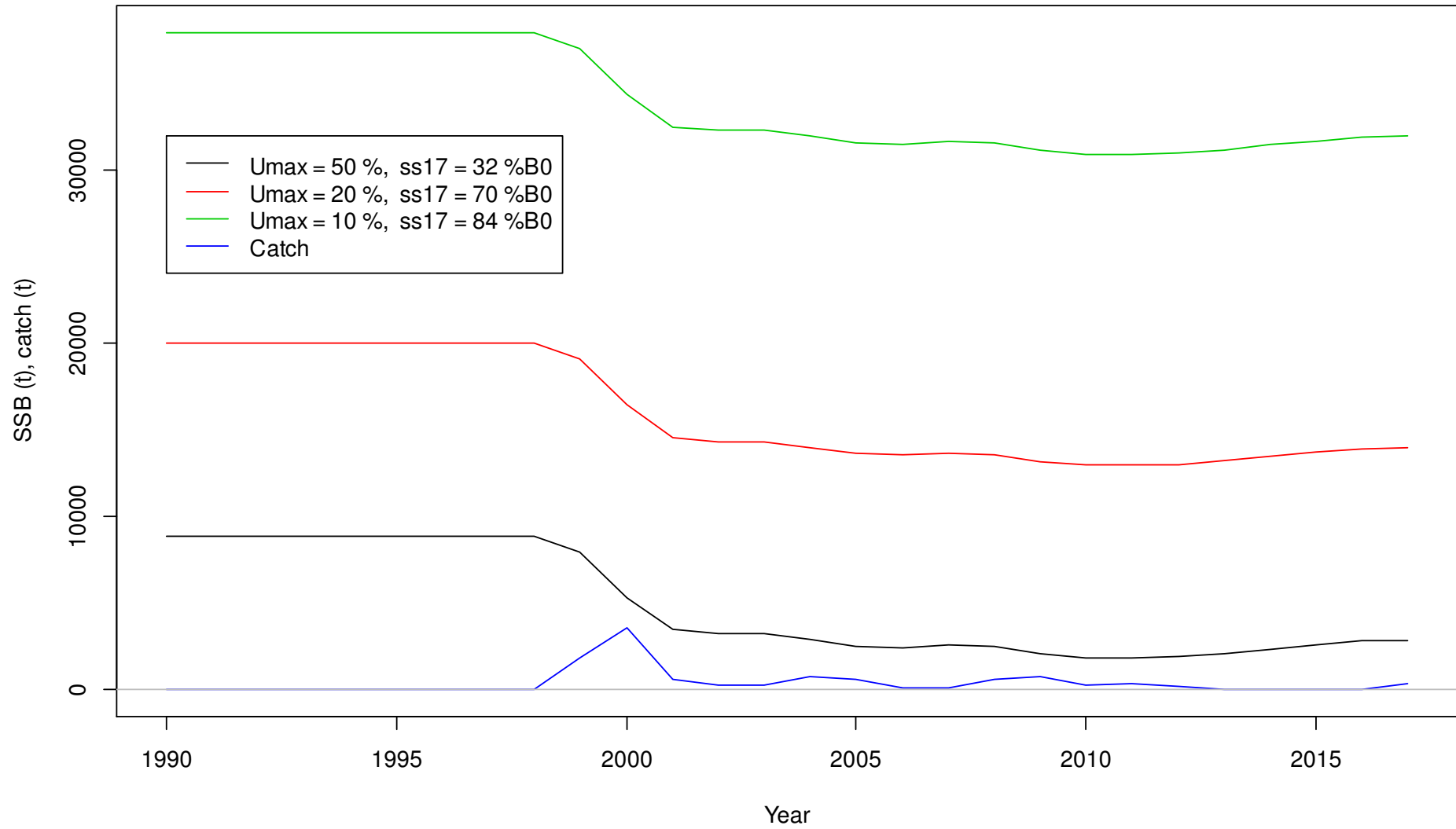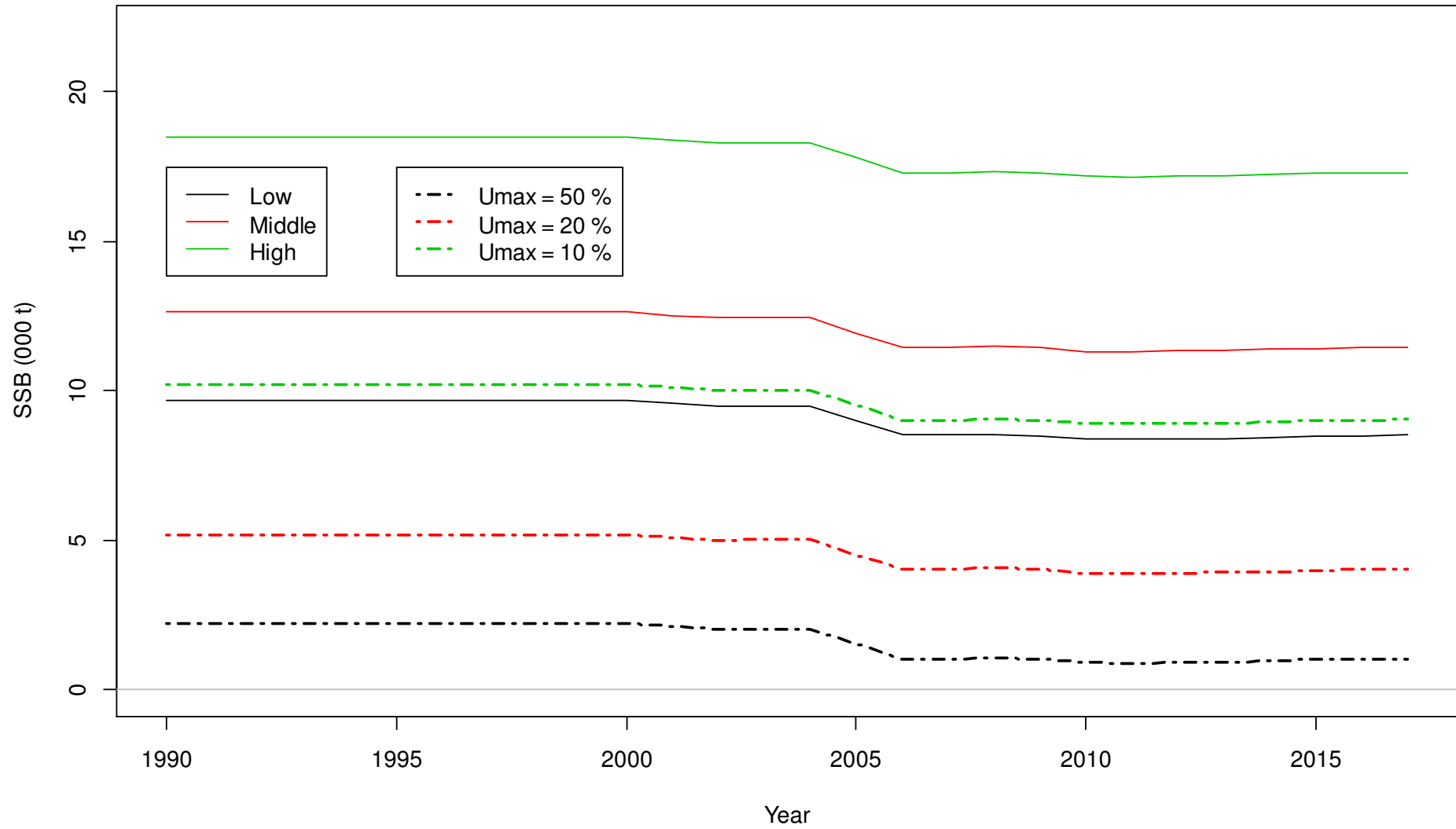
Catch-history based: South Ridge
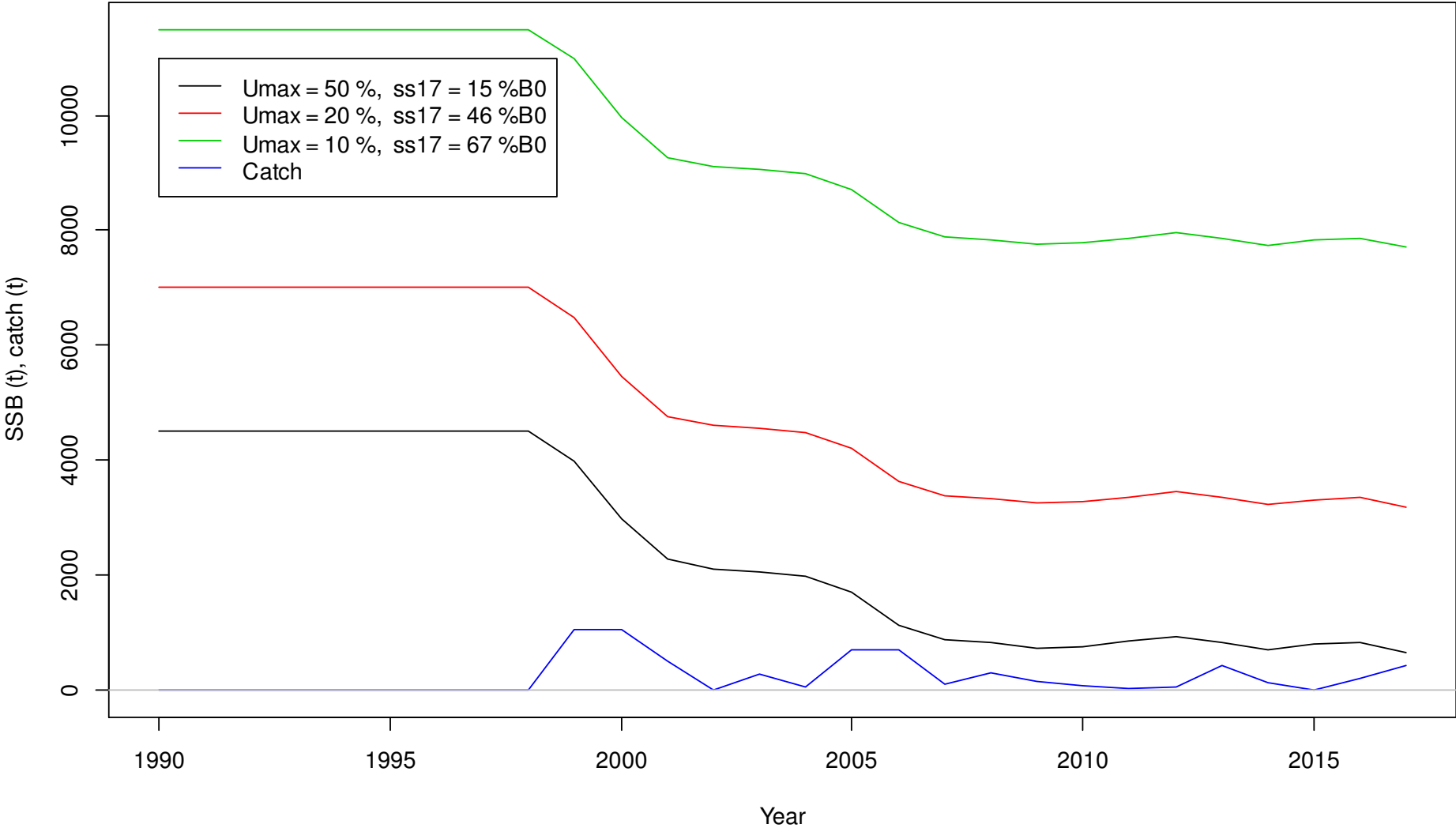
Applying the catch-history based method

- The key question is what is plausible in terms of a maximum exploitation rate for the whole "stock":
  - In the year of highest exploitation:
    - How many vessels were fishing the stock?
    - How many tows were done?
    - What proportion of the spawning features did they fish?
- U_{max} = 50% is only possible if most of the fish are accessible and there is a large effort over a large proportion of the features (in some year)
- We need to consider what U_{max} is appropriate for each stock (20%, 10%, or something else)
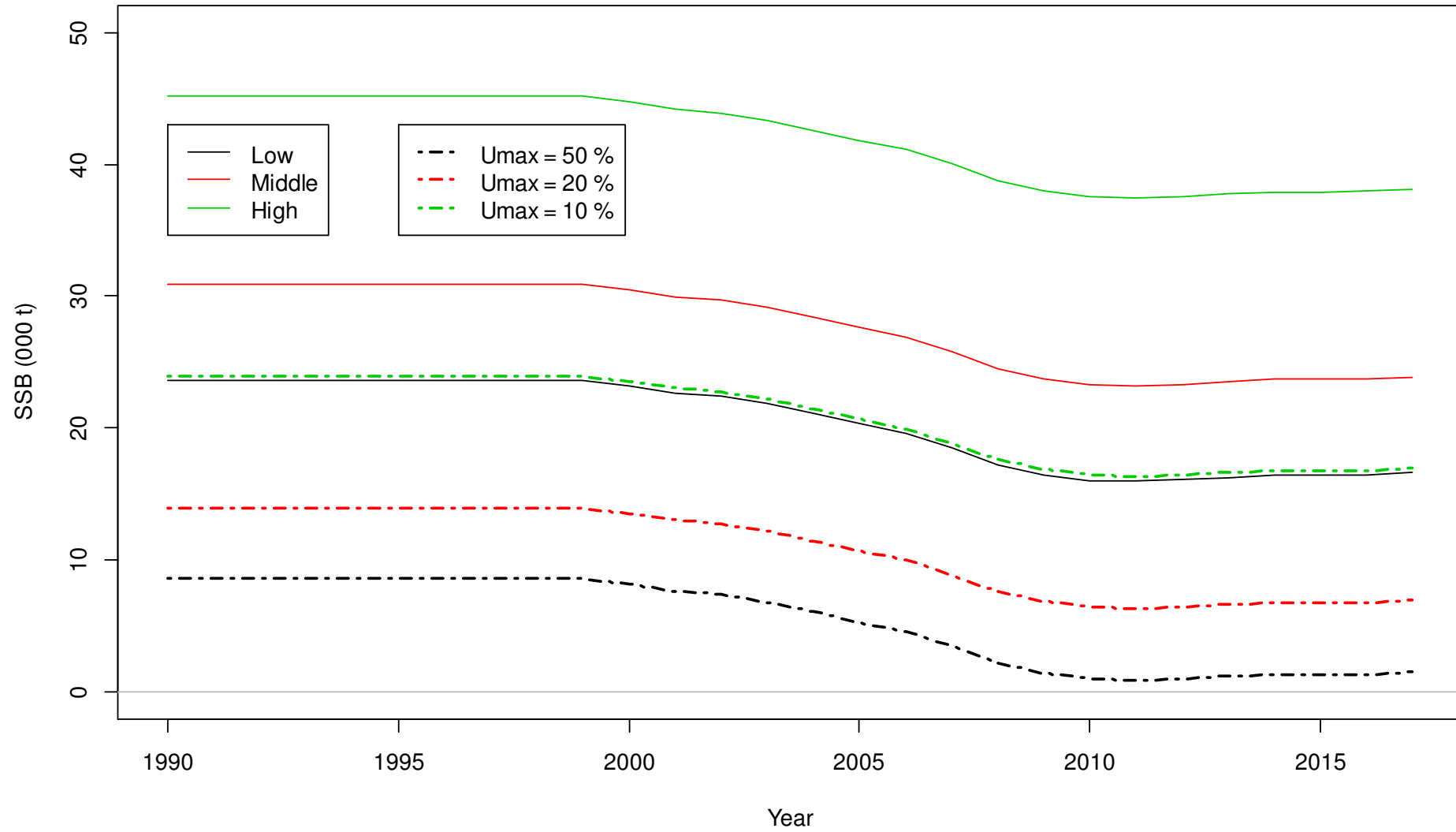
Results: MPD estimates

|		B_0 (000 t)	B_{17} (000 t)	B_{beg18} (000t)	ss_{17} (%B_0)	U_{HCR} (%)	Catch (t)
N. Walters	Low	9.7	8.5	8.6	88	5.625	480
	Middle	12.6	11.5	11.5	91	5.625	650
	High	18.5	17.3	17.3	94	5.625	980
Seamounts	Low	23.7	16.6	16.8	70	5.625	950
	Middle	30.9	23.9	24.1	77	5.625	1360
	High	45.1	38.1	38.3	84	5.625	2150
M. Ridge	Low	50.2	44.2	44.3	88	5.625	2490
	Middle	70.2	64.2	64.2	91	5.625	3610
	High	103.6	97.6	97.6	94	5.625	5490

MPD and catch-history based estimates: North Walters

MPD and catch-history based estimates: Seamounts

MPD and catch-history based estimates: Middle Ridge
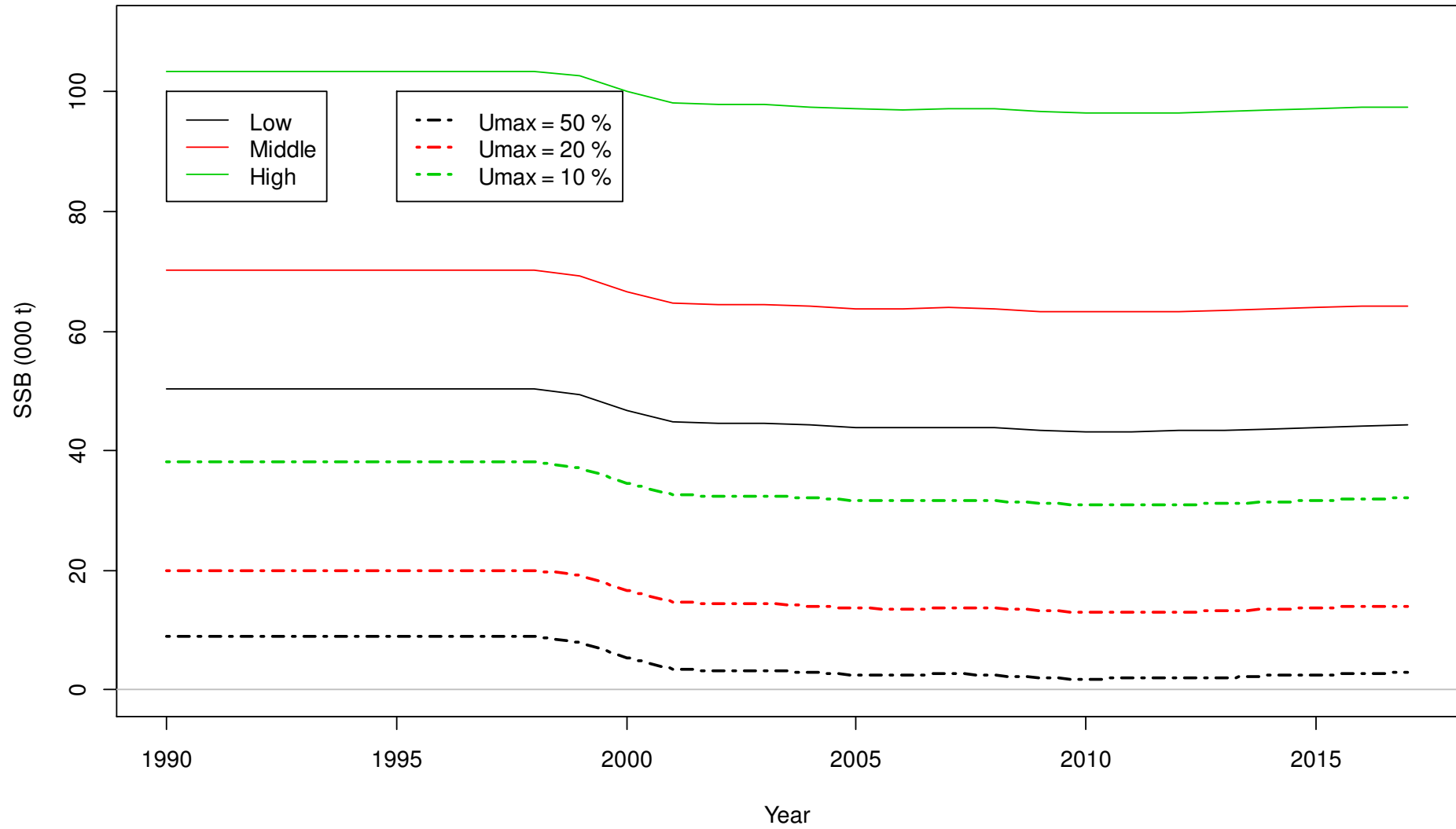
WSR results: MCMC, MPD, catch-history based

	B_0 (000 t)	B_{17} (000 t)	ss_{17} (%B_0)
Base (MCMC)	43	32	76
MPD	45	32	70
MPD (original aco)	47	31	66
Low (MCMC)	29	19	65
MPD	29	17	58
High (MCMC)	71	61	85
MPD	75	60	81
U_{max} = 50%	11	1.2	11
U_{max} = 20%	15	5.3	35
U_{max} = 10%	20	10	51

Interpretation of the MPD estimates

- Three different treatments deal with the potential biases associated with target strength, absorption coefficient, and analysis method
- No real concern about the results changing hugely if the survey estimates are revised/refined
- Only real issue is species mix for some features
- Need to consider which features may have unreliable acoustic estimates because of contamination from other species.

Recommendations:
work to be done at the SAWG workshop

- The results in the draft report are preliminary
- Catch histories may need to be updated
- Appropriate U_{max} values need to be agreed on for each stock (a base and perhaps a low and high value)
- The reliability of the acoustic estimates on features that may have mixed species needs to be considered
- In general, the MPD estimates based on acoustic estimates are to be preferred to the catch-history based estimates.