

Predictions: Short and long

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Kinds of predictions

- A) Short term deterministic projections of the stock forward
 - Part 1: TAC management: Derive the TAC 1-2 years onward, corresponding to some recommended fishing mortality
 - Part 2: Effort management: Relate the current fishing mortality to some recommended effort.
- B) Stochastic predictions
 - Short to medium term:
 - Risk evaluation
 - Simulation of Harvest Control Rule
 - Strategic advice
- C) Long term equilibrium
 - Deterministic
 - Yield per recruit and SSB per recruit
 - Stochastic
 - Optimum exploitation taken into account uncertainties

A) Short term deterministic projections: TAC management

- Done when the management strategy requires annual TAC decision based on the annual state of the stock.
- Technically:
 - 1) Project the stock forward from the current assessment with a given fishing mortality using the stock equation:

$$N_{a+1,y+1} = N_{a,y} e^{-(M_{a,y} + F_{a,y})}$$

- The $N_{a,y}$ values come from our historical assessment
- May need to make assumptions about recruitment
- In our world think of the current year being 1925 ($y=1925$) and that we may need to give advice to the managers for the year $y+1=1926$. The advice may be given in relation to the resulting SSB estimates in the year following the advisory year (i.e. $y+2=1927$).

“The map” extending forward: Nay values

	M	N	O	P	Q	R	S	T	U	V	W	X
43	Population numbers (Nay)											
44	Year\Age	1	2	3	4	5	6	7	8	9	10	11
45	1900	212	55	202	43	27	22	11	7	6	4	7
46	1901	111	173	45	165	34	20	15	7	4	3	6
47	1902	65	91	142	37	131	26	13	9	4	2	5
48	1903	303	53	75	116	29	97	17	8	5	2	3
49	1904	200	248	44	61	92	22	66	10	4	3	3
50	1905	143	164	203	35	48	68	14	39	6	2	3
51	1906	166	117	134	165	28	36	45	8	21	3	3
52	1907	95	136	96	109	131	21	24	27	5	11	3
53	1908	147	78	112	78	87	97	14	14	14	2	7
54	1909	176	121	64	91	62	64	64	8	7	7	5
55	1910	23	144	99	52	72	45	42	37	4	4	6
56	1911	230	19	118	80	41	52	29	23	18	2	4
57	1912	100	188	15	96	63	30	33	16	11	9	3
58	1913	307	82	154	12	76	46	19	18	8	5	5
59	1914	47	251	67	125	10	55	29	10	9	4	5
60	1915	104	39	205	54	98	7	33	15	5	4	3
61	1916	161	85	32	167	43	71	4	18	7	2	3
62	1917	151	132	70	26	131	30	43	2	8	3	2
63	1918	120	124	108	57	20	92	18	21	1	3	2
64	1919	42	98	101	87	44	14	55	9	9	0	2
65	1920	165	35	80	82	68	31	8	27	4	4	1
66	1921	100	135	28	65	64	48	18	4	11	2	2
67	1922	53	82	111	23	51	45	28	9	2	4	1
68	1923	124	43	67	90	18	35	26	13	4	1	2
69	1924	35	101	35	54	70	12	20	12	5	1	1
70	1925		28	83	29	42	48	7	9	5	2	1
71	1926											
72	1927											
73	1928											

Need to assume something about recruitment

A) Short term deterministic projections: TAC management

- 2) If the fishery is dependent on incoming recruits may need, if no survey measurements are available, to make assumption about the size of those recruits (the youngest age classes).
- 3) Once you have the future $N_{a,y}$ one can derive the catch from the catch equation:

$$C_{a,y} = \frac{F_{a,y}}{F_{a,y} + M_{a,y}} \left(1 - e^{-(F_{a,y} + M_{a,y})} \right) N_{a,y}$$

- 4) Derive yield from the predicted $C_{a,y}$ (TAC advice) with some assumed weights in catch:

$$Y_y = \sum_a C_{a,y} w_{a,w}$$

A) Short term deterministic projections: TAC management

- 5) Derive SSN from the predicted $N_{a,y}$ with some assumed weights in the stock ($w_{a,y}$) and maturity at age ($m_{a,y}$):

$$SSB_y = \sum_a N_{a,y} w_{a,y} m_{a,y}$$

We already know how this is done

- In the forward based statistical catch at age world there is **no mathematical difference** between a historical assessment vs. the short and medium and long term predictions.
- And this applies to:
 - Short term predictions (assessment year, advisory year and the year after the advisory year)
 - Medium term simulations (5-15 years)
 - Yield per recruit calculation

- The assumption needed:
 - Selection in the fishery (s_a)
 - If the model is a separable model, use the estimated selection pattern
 - If the model is not a separable model, use the F 's over some recent year and normalize the values to some reference age group.
 - Weight and maturity at age
 - Usually some average of the recent years is taken
 - Recruitment
 - In the short term we use often the mean, for those year classes were no measurement exist
 - If the fishery is heavily dependent on recruitment of which there is no information on, a management with TAC derived this way is most likely not appropriate.
 - Natural mortality
 - Use the same one as used in the assessment.

Lets turn back the clock to start of 1914

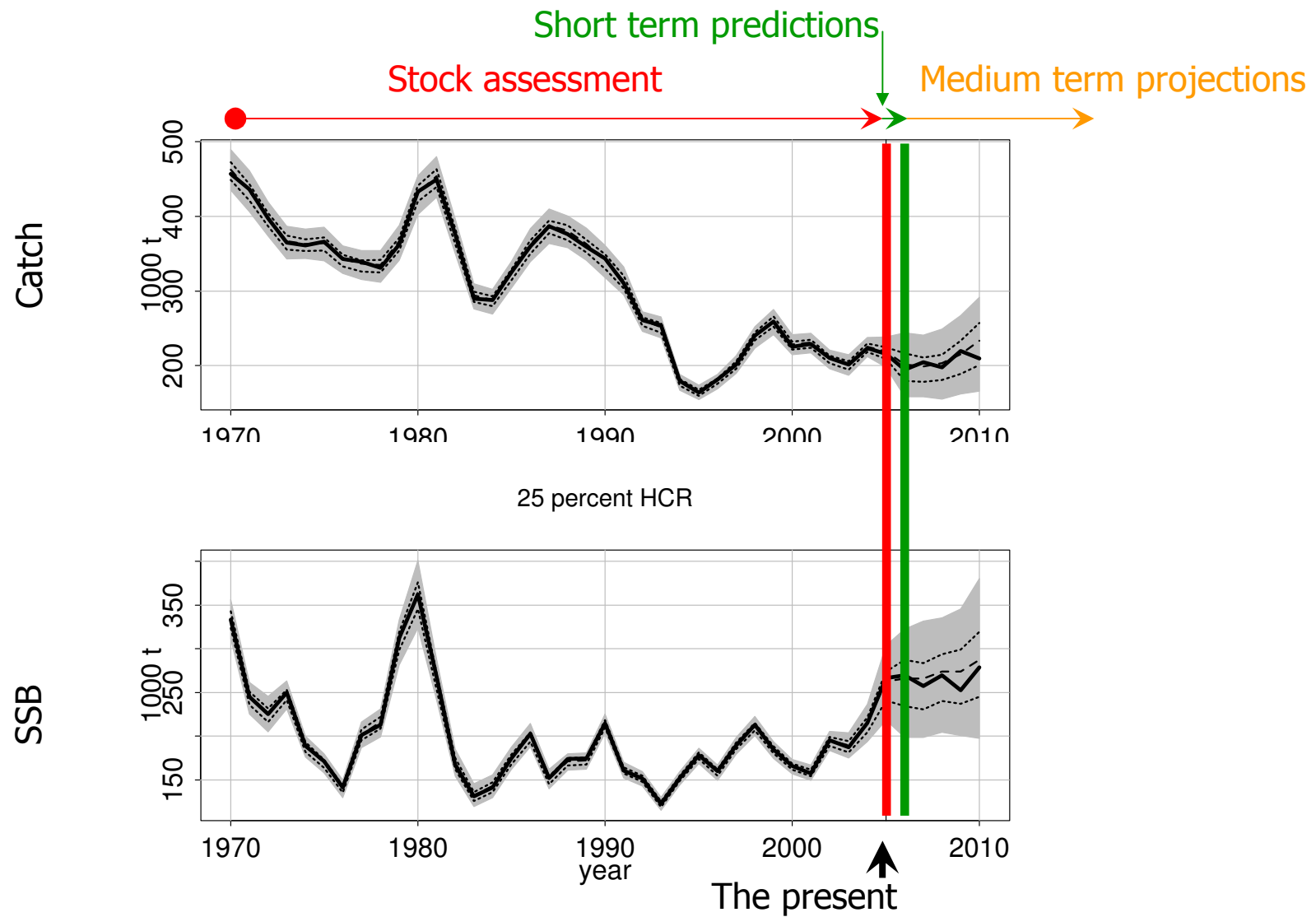
- Up until now we have been doing assessment as if the present (assessment) year was 1925.
 - Have thus had both catch at age and survey indices up till and including year 1924.
- Since we have been operating as if the present was 1925, can just as easily operate as if the present was 1914!
 - Lets add to the twist that we have the survey indices for the year 1914
 - Just image that the survey happens in the beginning of 1914 and that the data are available.
- See xModel.xls in directory 04Predictions

Short term predictions: Our assessment year is 1914

- In our case this means we have the following measurements:
 - c@a up until 1913
 - Two survey indices up until start of 1914
- We have thus the following estimates based on the assessment:
 - Fishing mortality by age and year in 1913
 - Population numbers by age and year in start of 1914 based on predictions from direct measurements.
- Our short term objective is to give managers TAC advice for the next advisory year, i.e. for 1915. Including in such an advice is information about the consequences of such an advice. I.e. what is the most likely biomass in the start of 1916 going to be after a certain catch has been taken in 1915.
- In the short term deterministic predictions we normally assume that the incoming recruits is some average of the past.

B) Stochastic predictions

- Same equations, except we add stochastic elements to at least some of our future values.
 - Most often only do this for the recruitment
- Recruitment stochastic projection:
 - Most often use SSB to predict future recruitment
 - Ricker or Beverton_Hold model
 - Here we just show how one do stochastic projections by picking past recruitment values from our assessment
 - i.e we are effectively assuming the recruitment is independent of stock size.
 - In you xModel.xls (in the folder 04Predictions) change the value of cell E27 from 1 to 0.
 - Go to the area where your Nay matrix is (starting in cell N45). Press F9 numerous times – and you are generating stochastic recruitments
 - Go to the Summary worksheet and press again F9 numerous times



C) Long term equilibrium

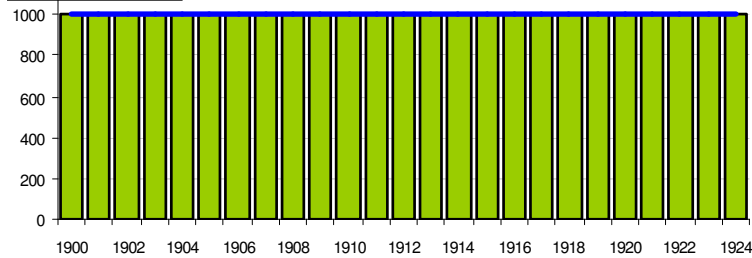
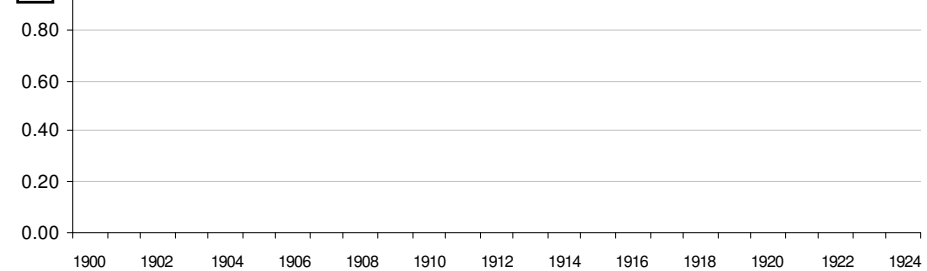
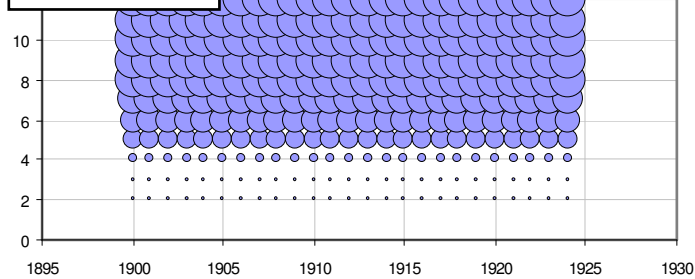
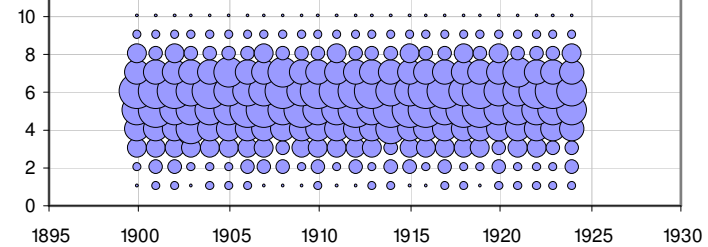
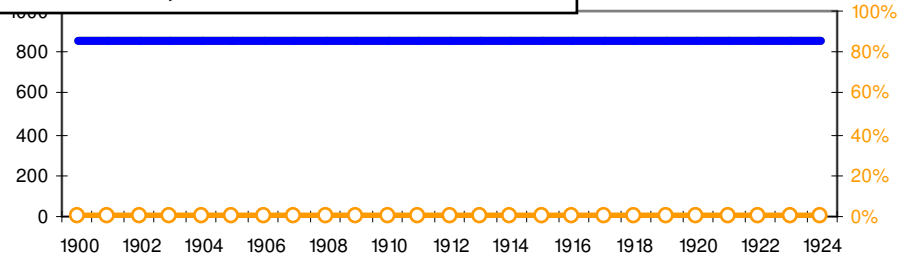
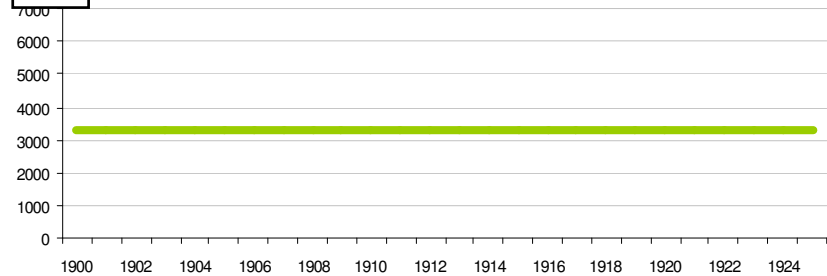
- The yield per recruit and the SSB per recruit models are just a simplified version of things we have already done.
 - Again, we use exactly the same equation
 - We only assume that recruitment is constant (hence “per recruit”)

- We could do a yield per recruit calculation in our simulator, just keep everything constant:
 - Recruitment (no stochasticity)
 - Selection pattern (sa)
 - Weights and maturity at age

- Except trying different values of F

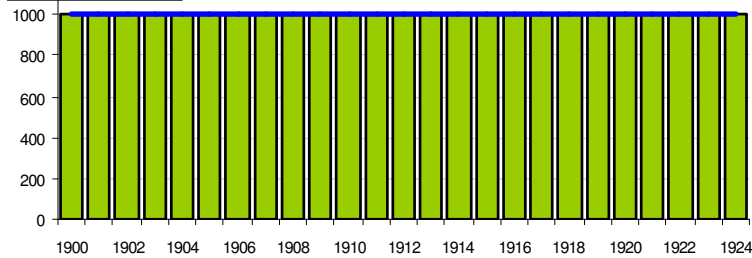
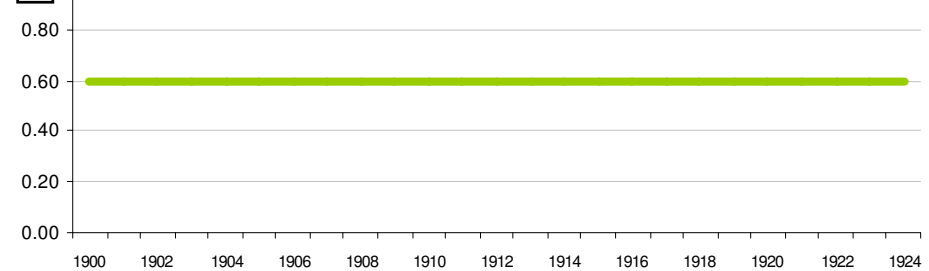
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Yield and SSB per 1000 recruits: $F = 1.00$

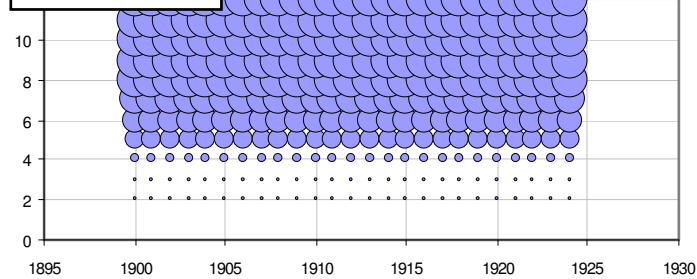
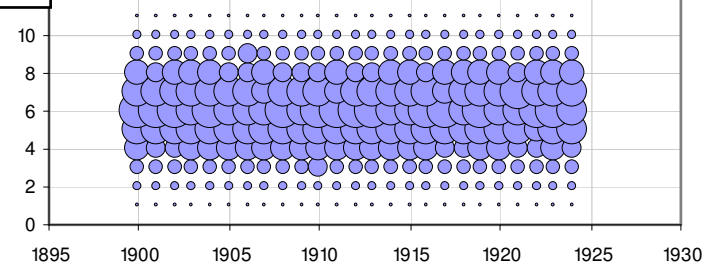
Recruitment**F****Fishing pattern****c@a****Yield: Actual, accounted & unaccounted****SSB**

Yield and SSB per 1000 recruits: $F = 0.60$

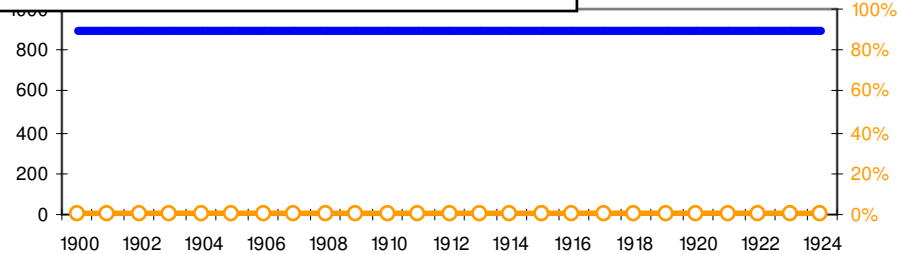
Recruitment

 F 

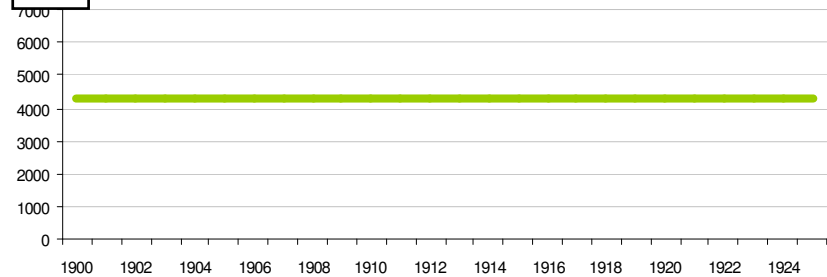
Fishing pattern

 $c@a$ 

Yield: Actual, accounted & unaccounted

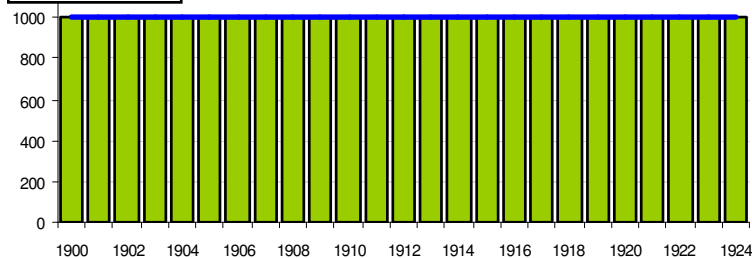
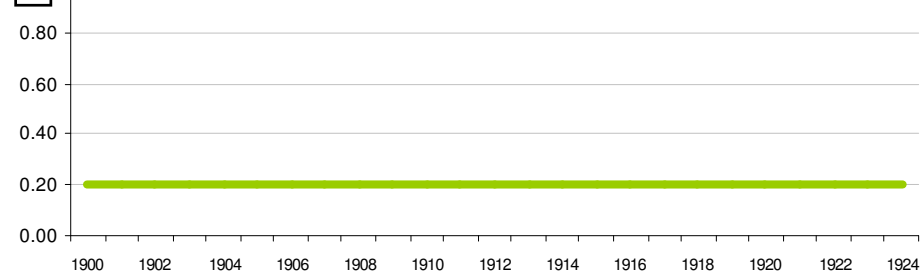
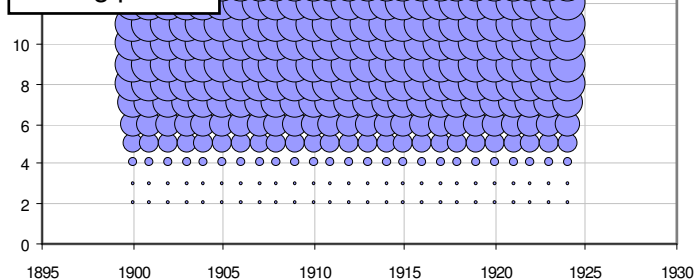
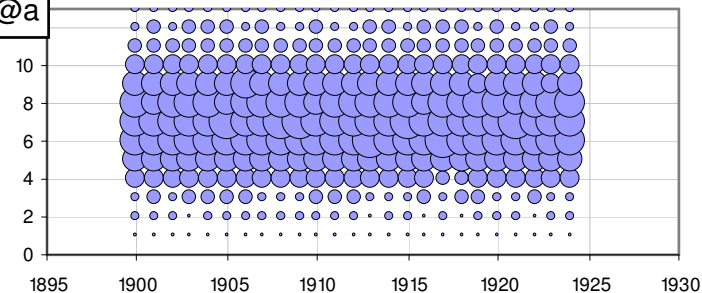
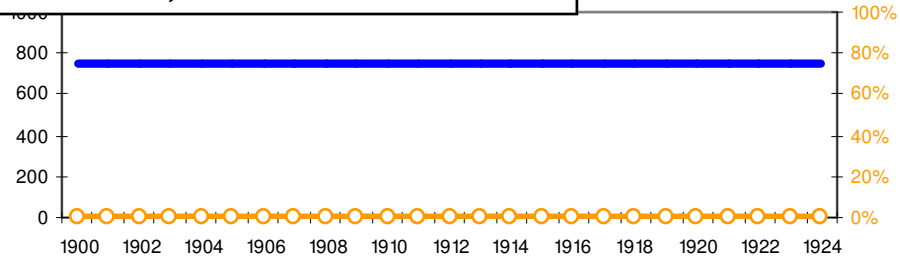
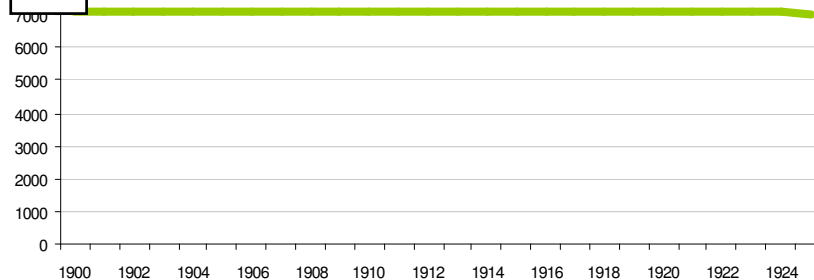


SSB



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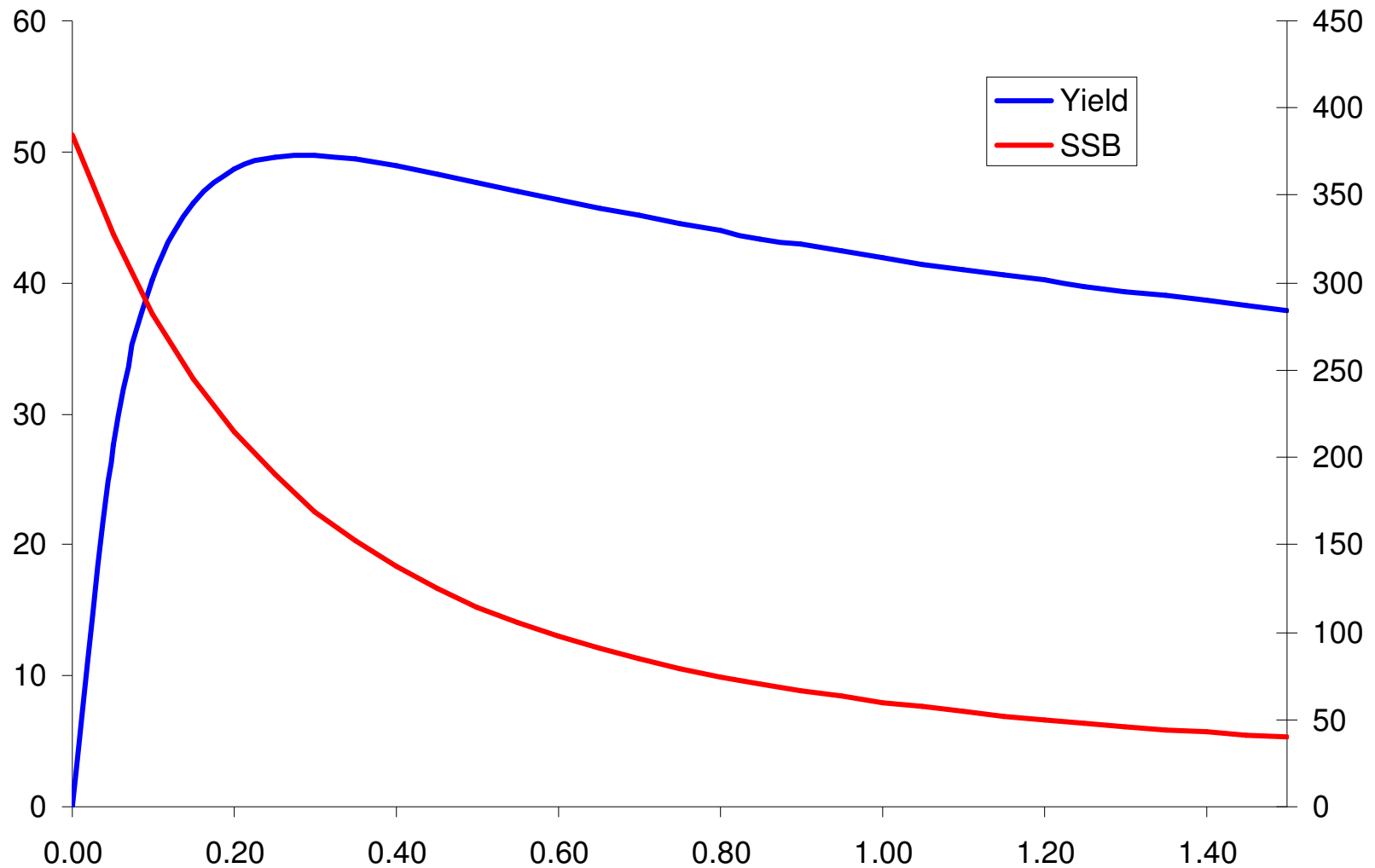
Yield and SSB per 1000 recruits: $F = 0.20$

Recruitment**F****Fishing pattern****c@a****Yield: Actual, accounted & unaccounted****SSB**

See xModel.xls/Model area starting in cell BW1

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Normally calculated from 1 cohort only



Fishing mortality (of reference age group)