Empirical dynamic modelling summary

EDM group

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Canada

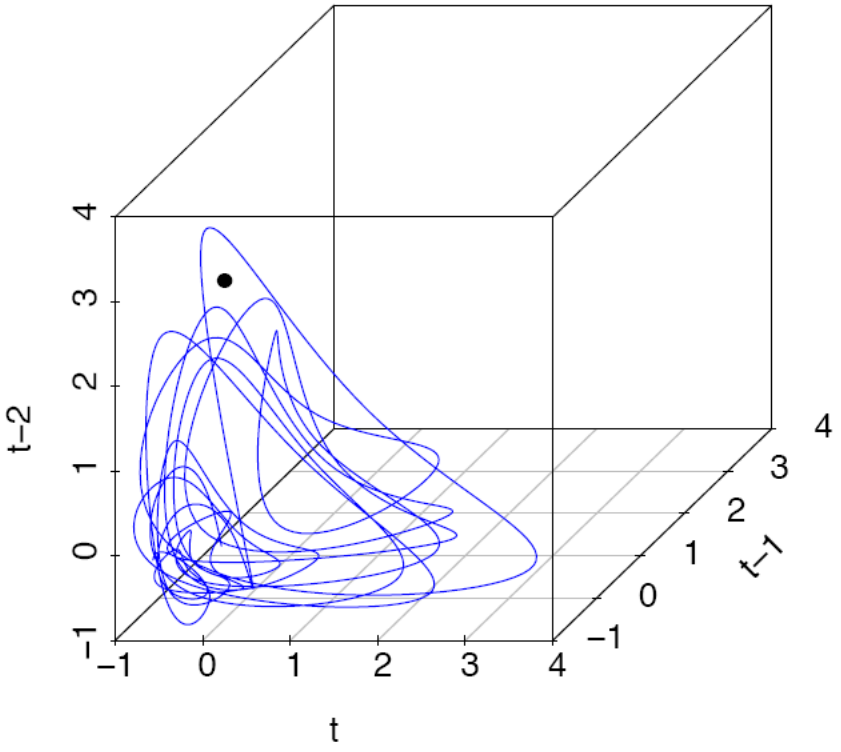
Background

"Incorporating an ecosystem approach into single-species stock assessments"

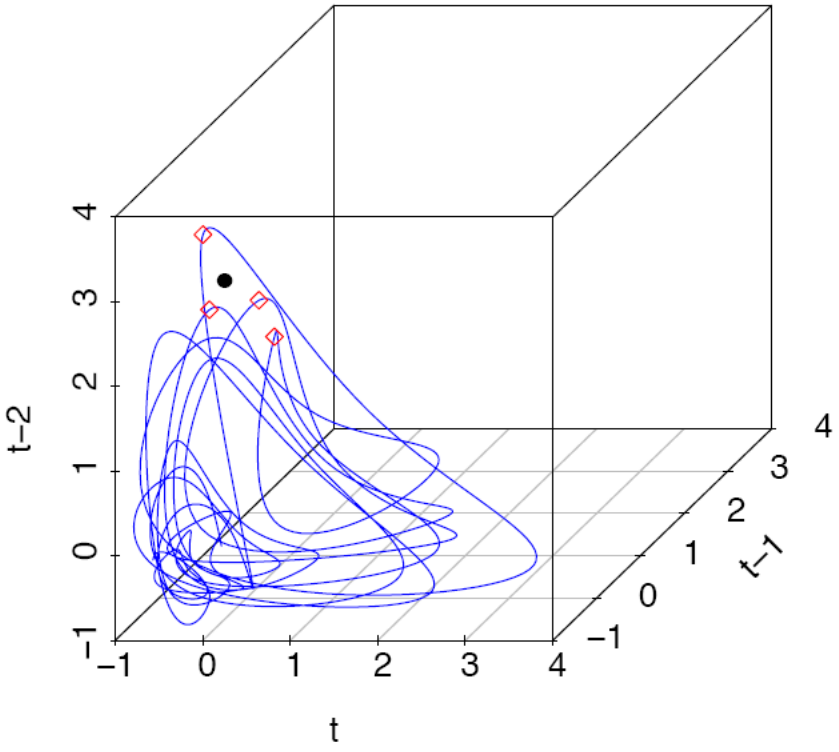
This is a different approach, more like:

"An approach for analysing ecosystem influences on single (or multiple) species."

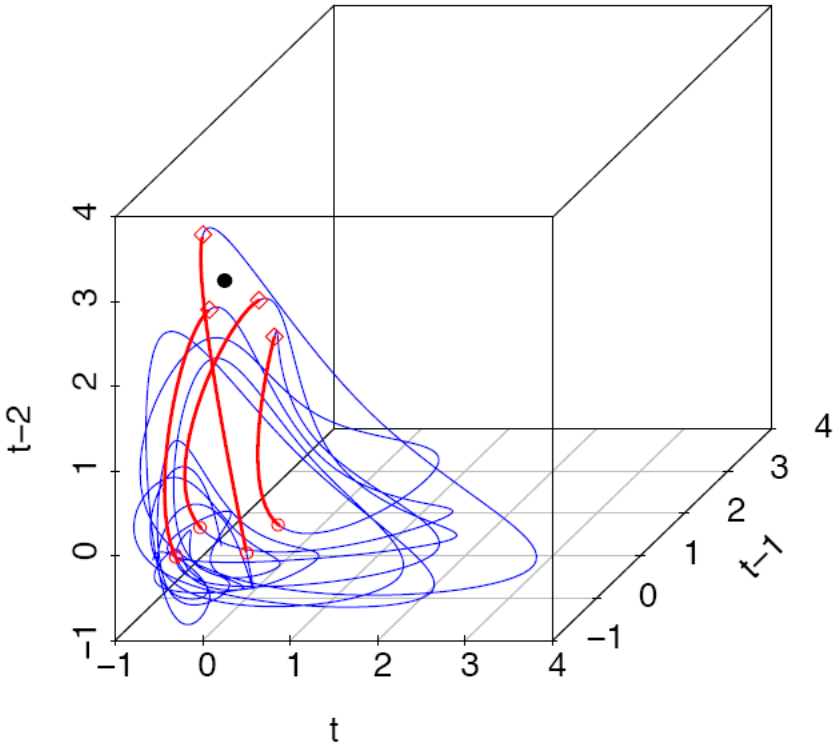
Simplex Projection



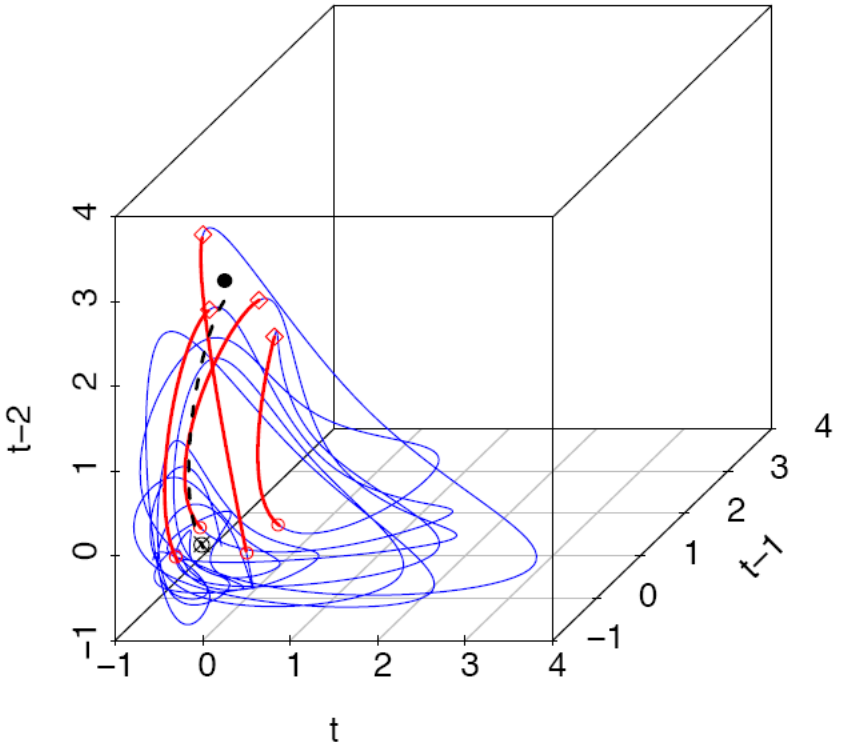
Simplex Projection



Simplex Projection



Simplex Projection



What we did

1. rEDM package – works well, we understand some of it (worked through some of vignette). Data input challenging.

2. Random data – gives nonsense. Deterministic model – does well.

3. Read paper – Sugihara and May (1990).

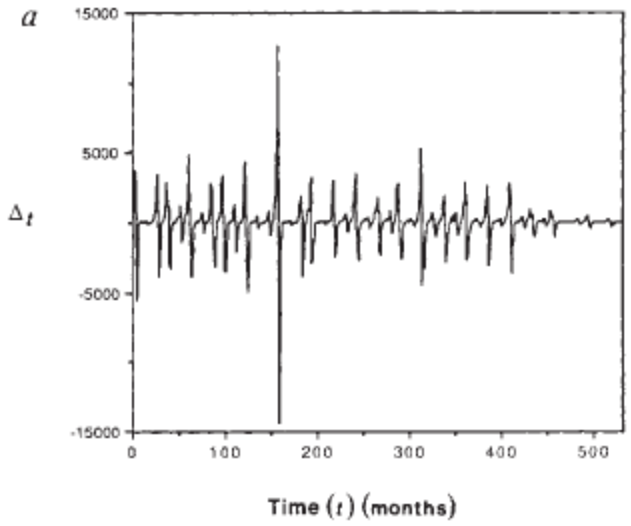
4. Salmon – tried to replicate some results.

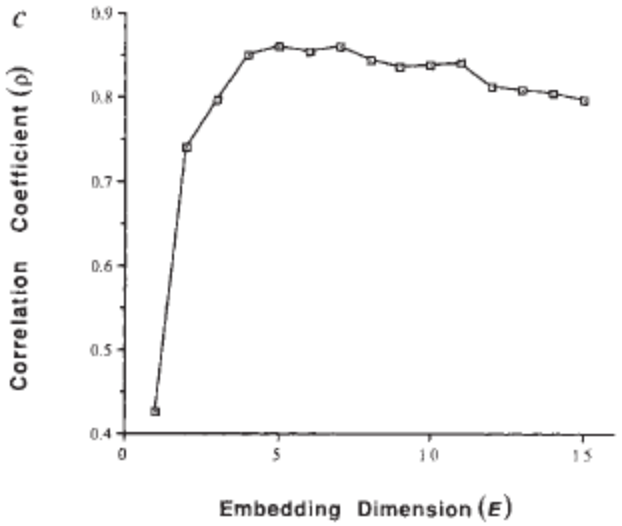
5. Salmon – updated data set. Predictability similar, best models different.

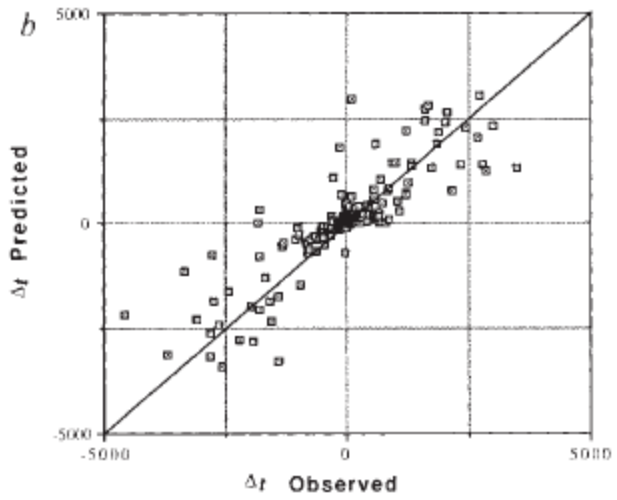
6. Real data – crab data: R1, R2, R3.

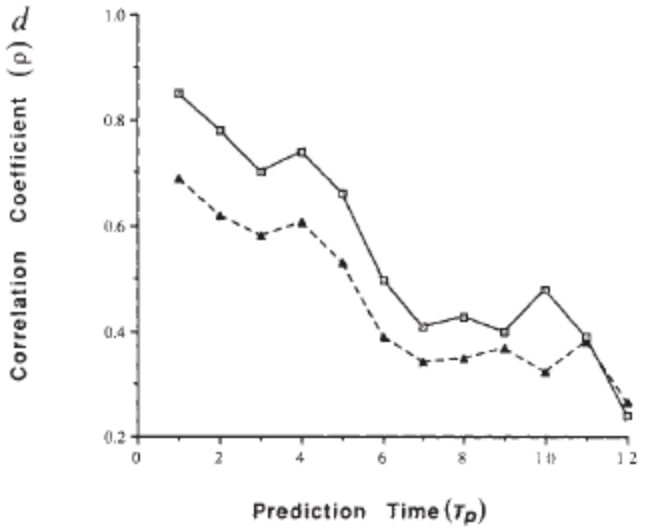
7. Simulated competition model.

Helpful paper









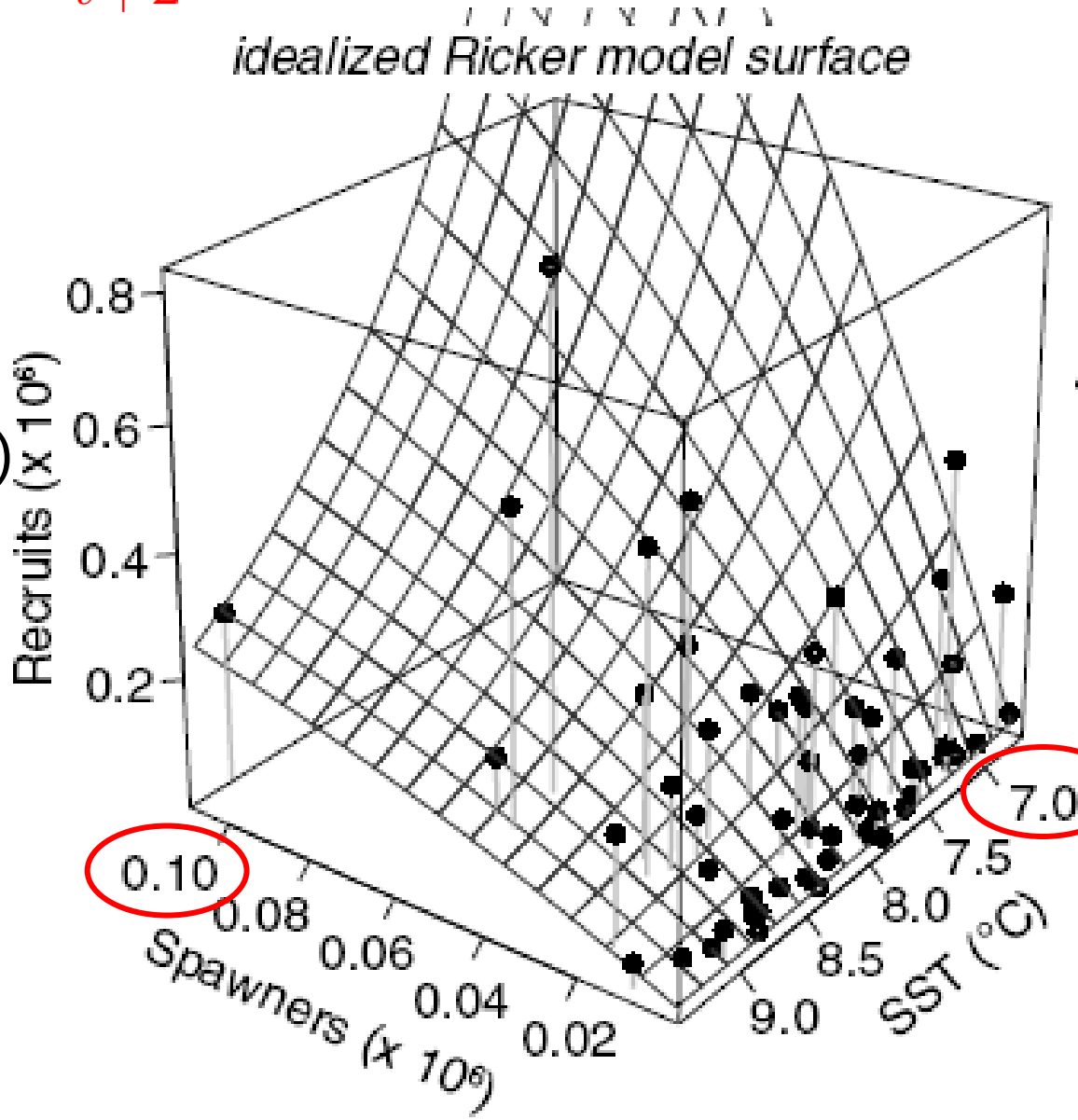
Sugihara and May, 1990, Nature, 344:734.

Salmon – incorporate temperature

$$\hat{R}_t = S_t e^{\alpha - \beta S_t + \gamma U_{t+2}}$$

Low (but attainable) SST, with high (but attainable) spawners, predicts ridiculously high (historically unattainable) recruits.

Prescribing above equation gives only one hypothesis for how temperature can affect recruitment.

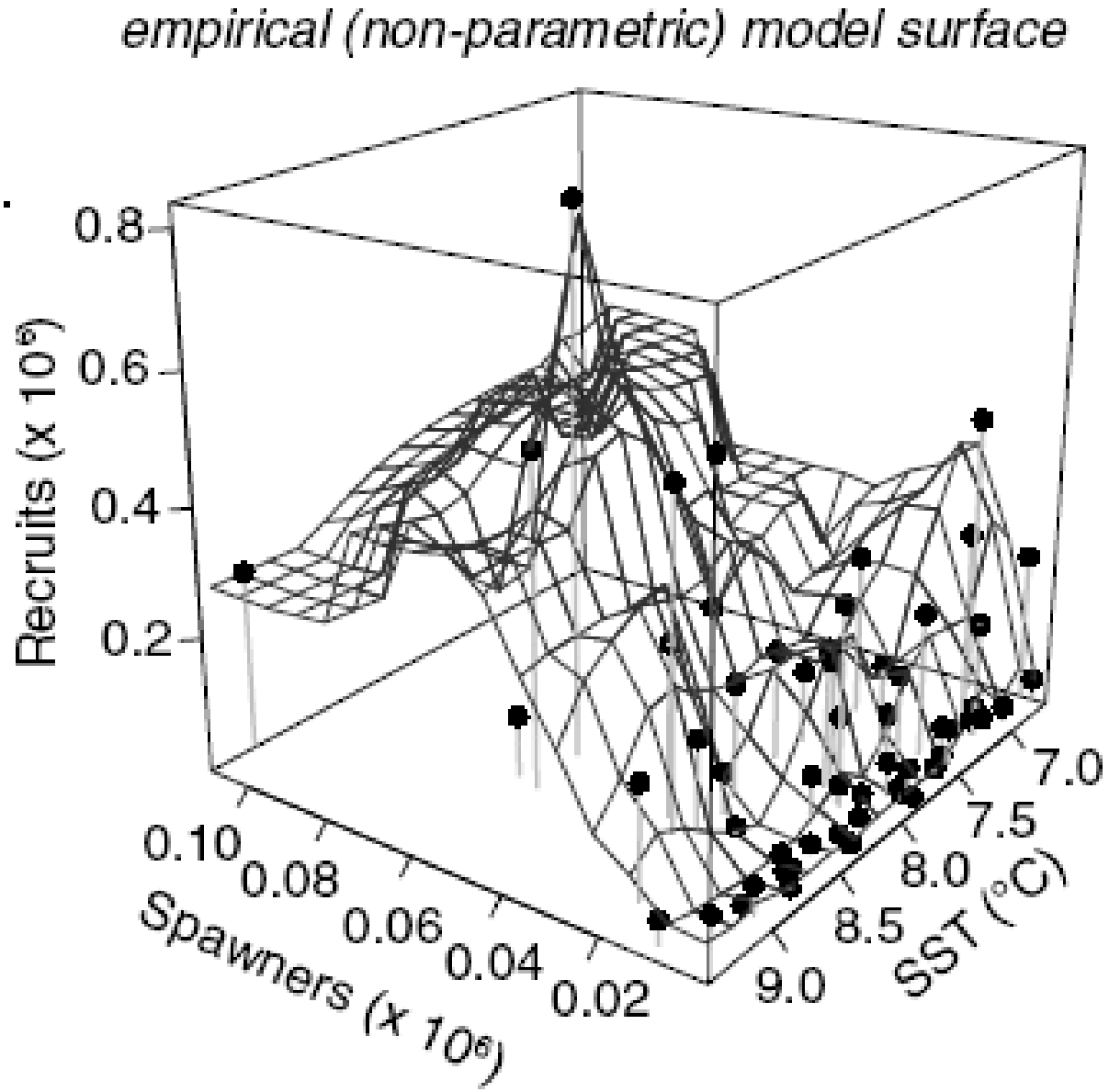


EDM approach

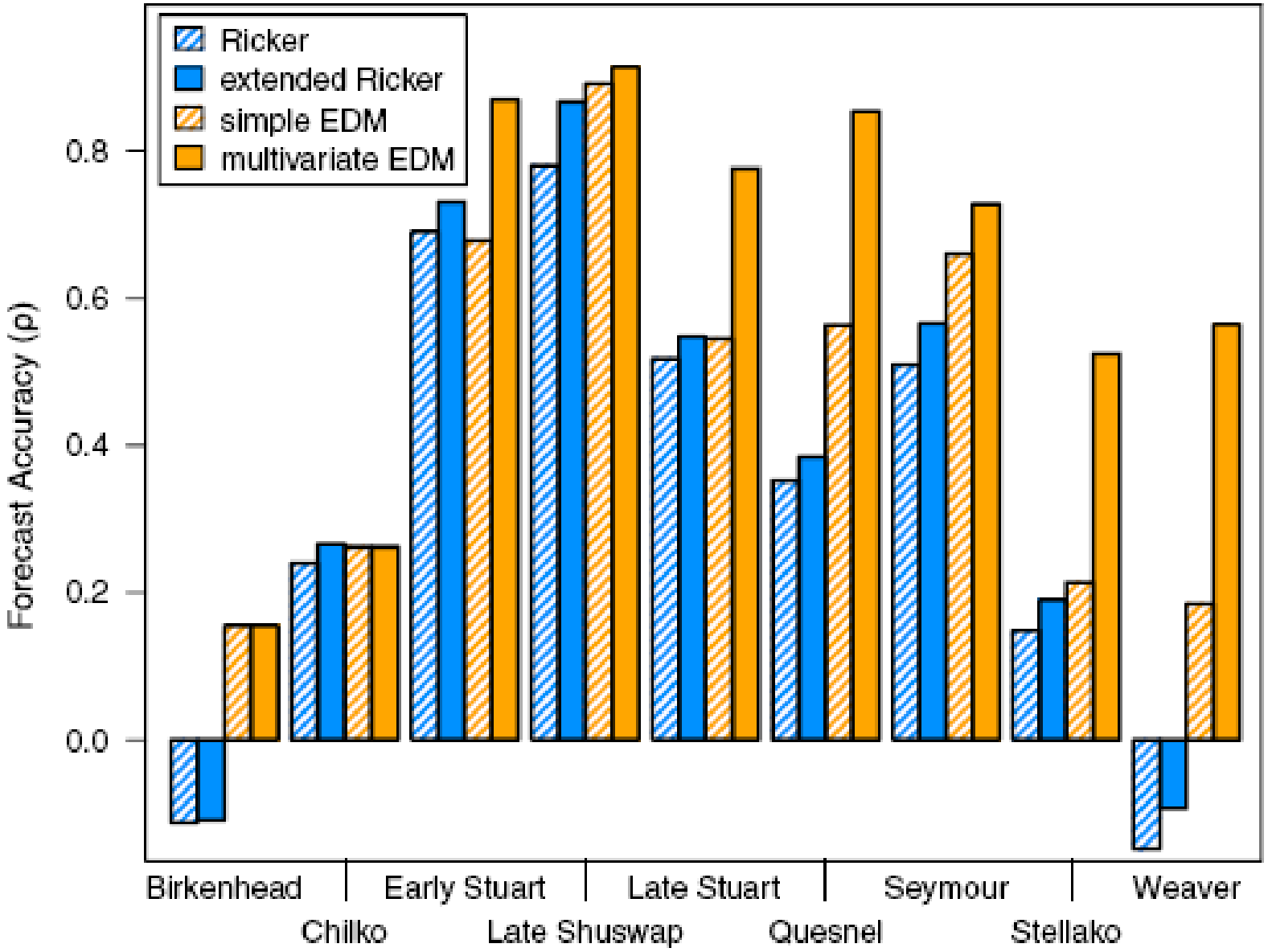
No equation specified.

No hypothesised relationship.

Just uses data.

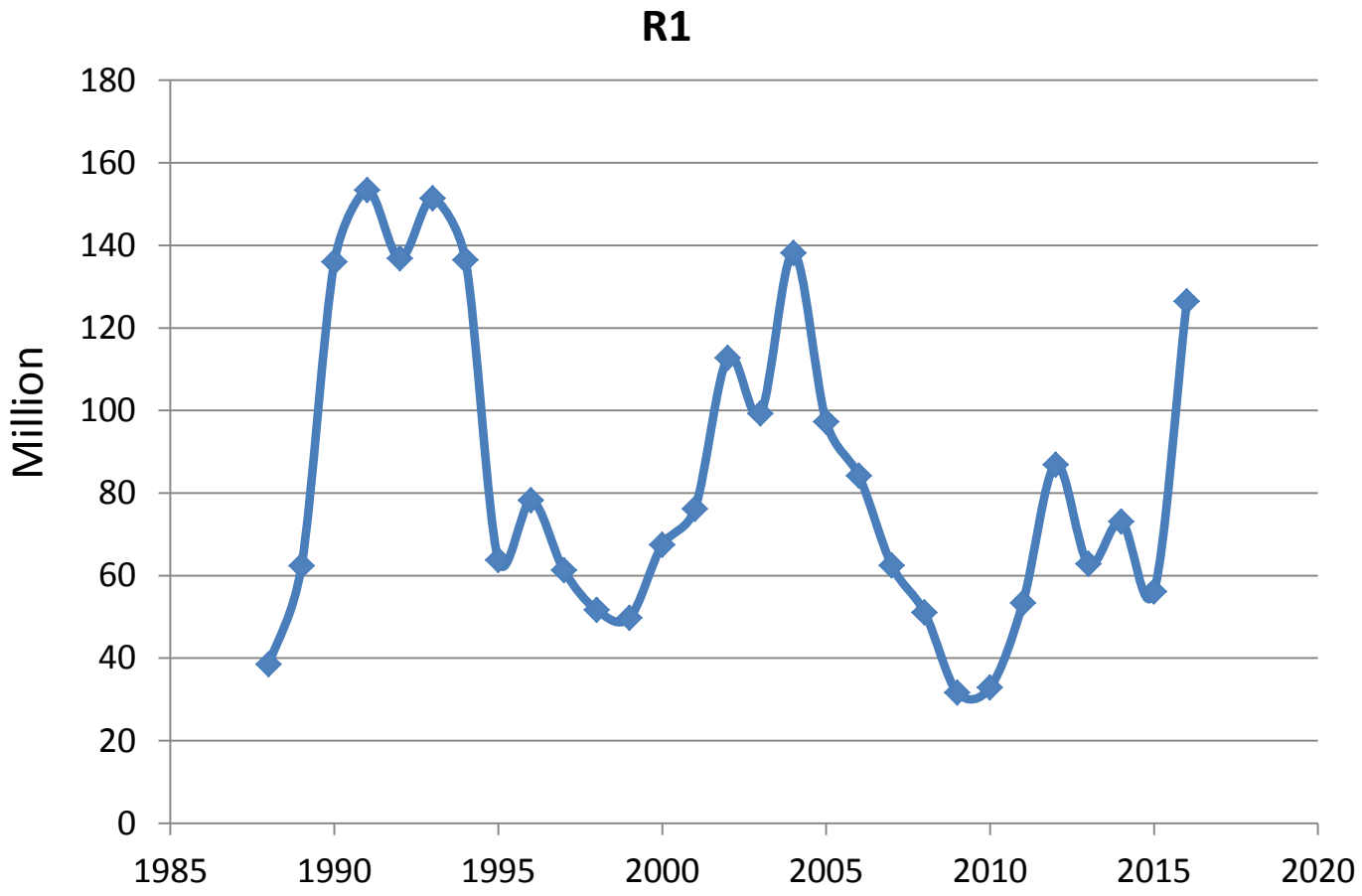


Forecast accuracy

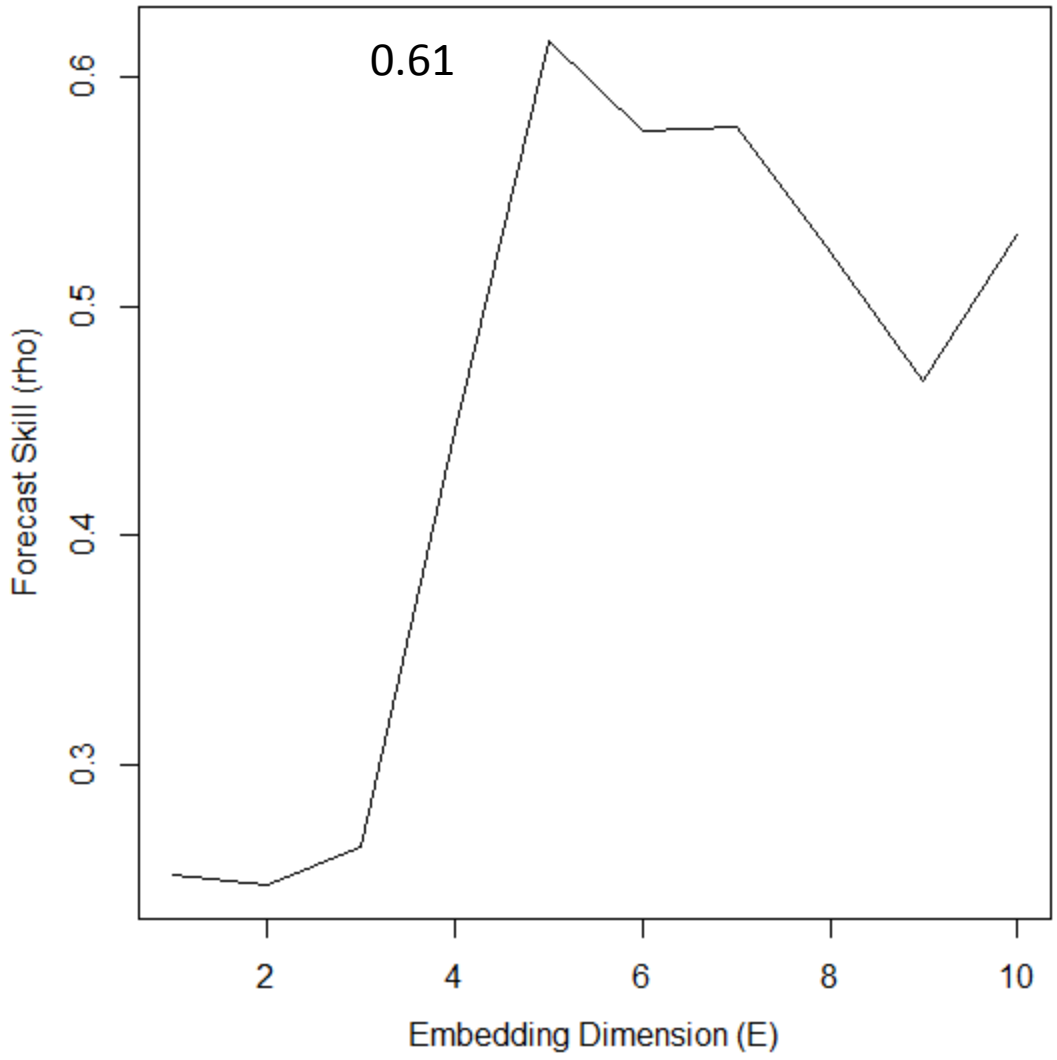


Crab data

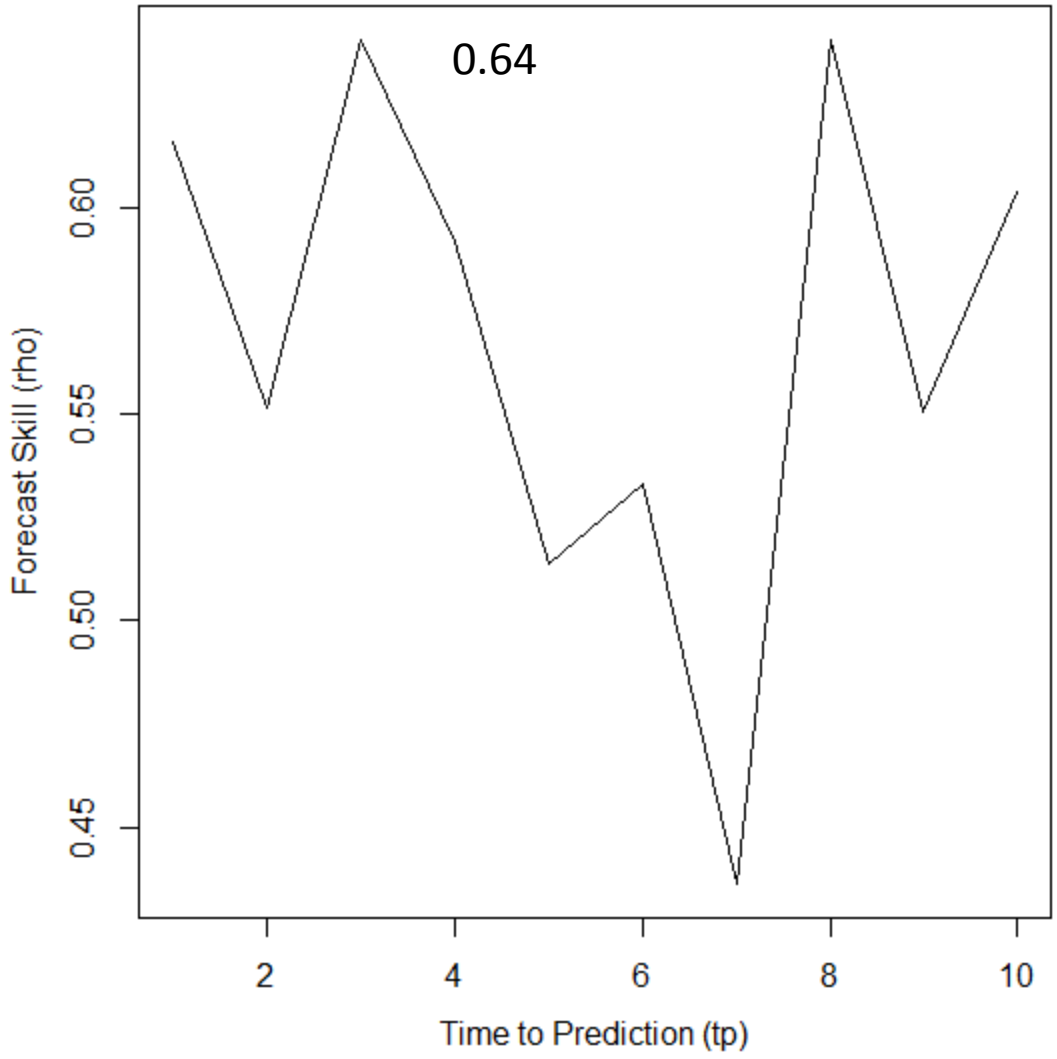
R1 (recruitment one year prior to entering fishery- Male mature gt 95mm)



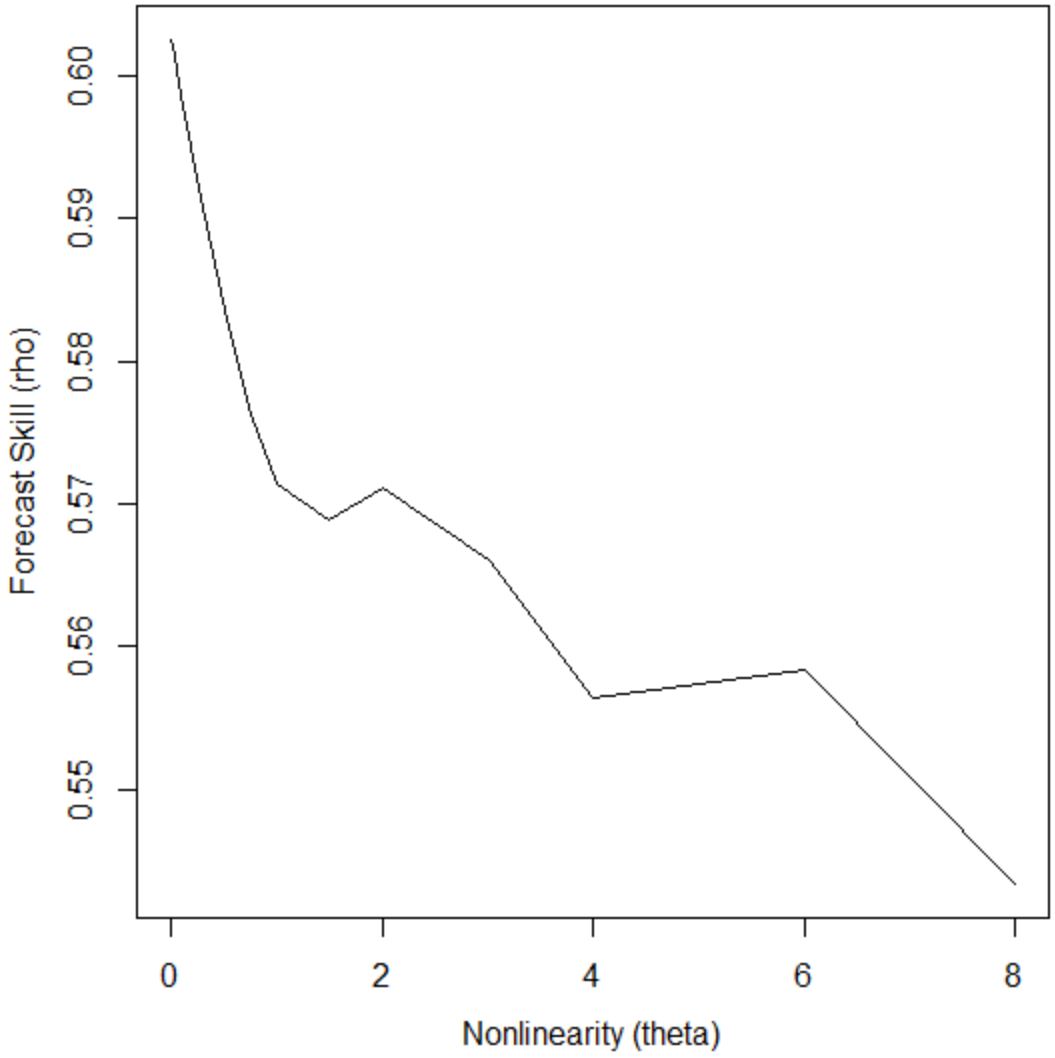
R1 (Male mature gt 95mm)



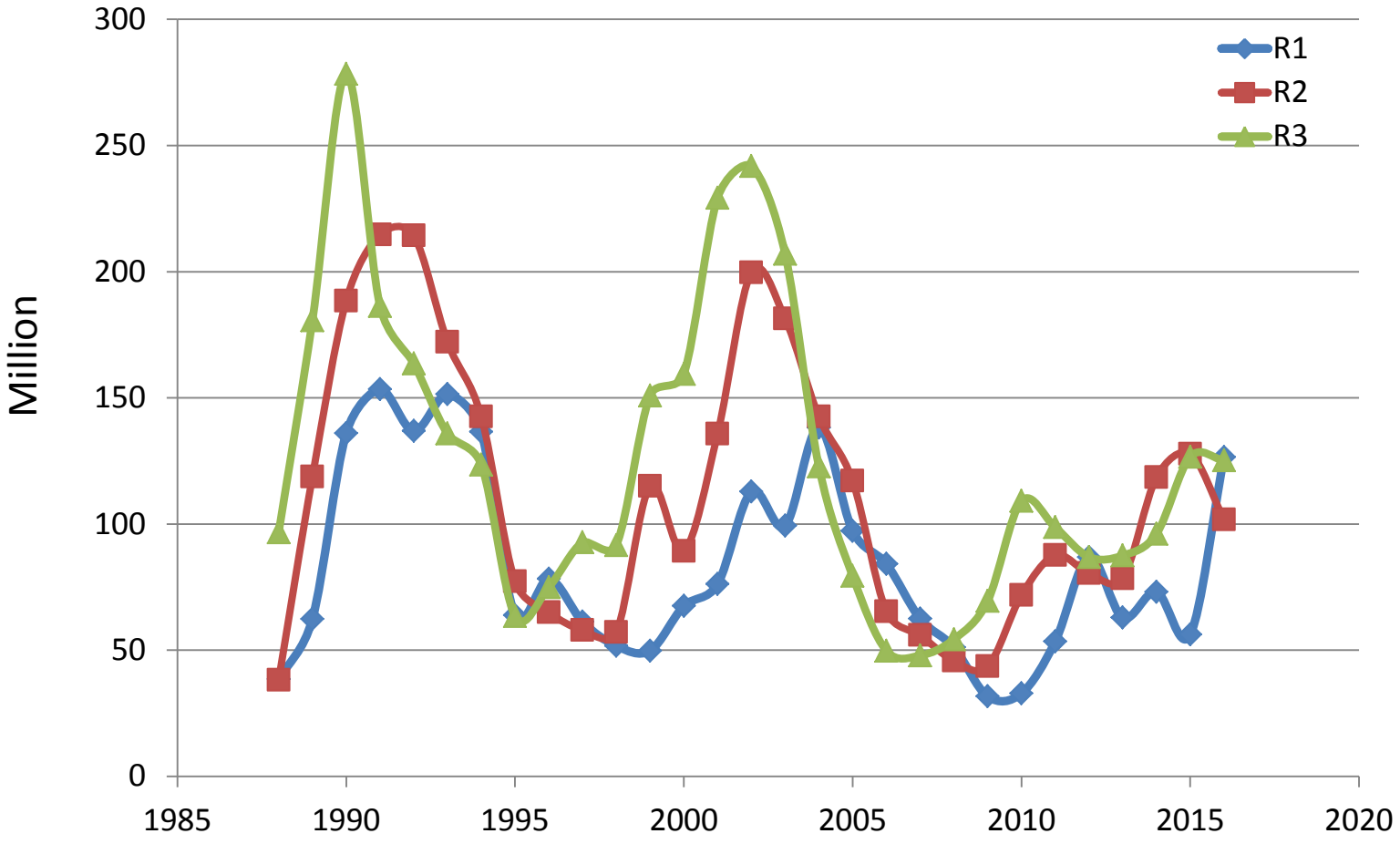
Embedding dimension E = 5



S-map


Forecast Skill (rho)
0.55
0.56
0.57
0.58
0.59
0.60
0
2
4
6
8
Nonlinearity (theta)

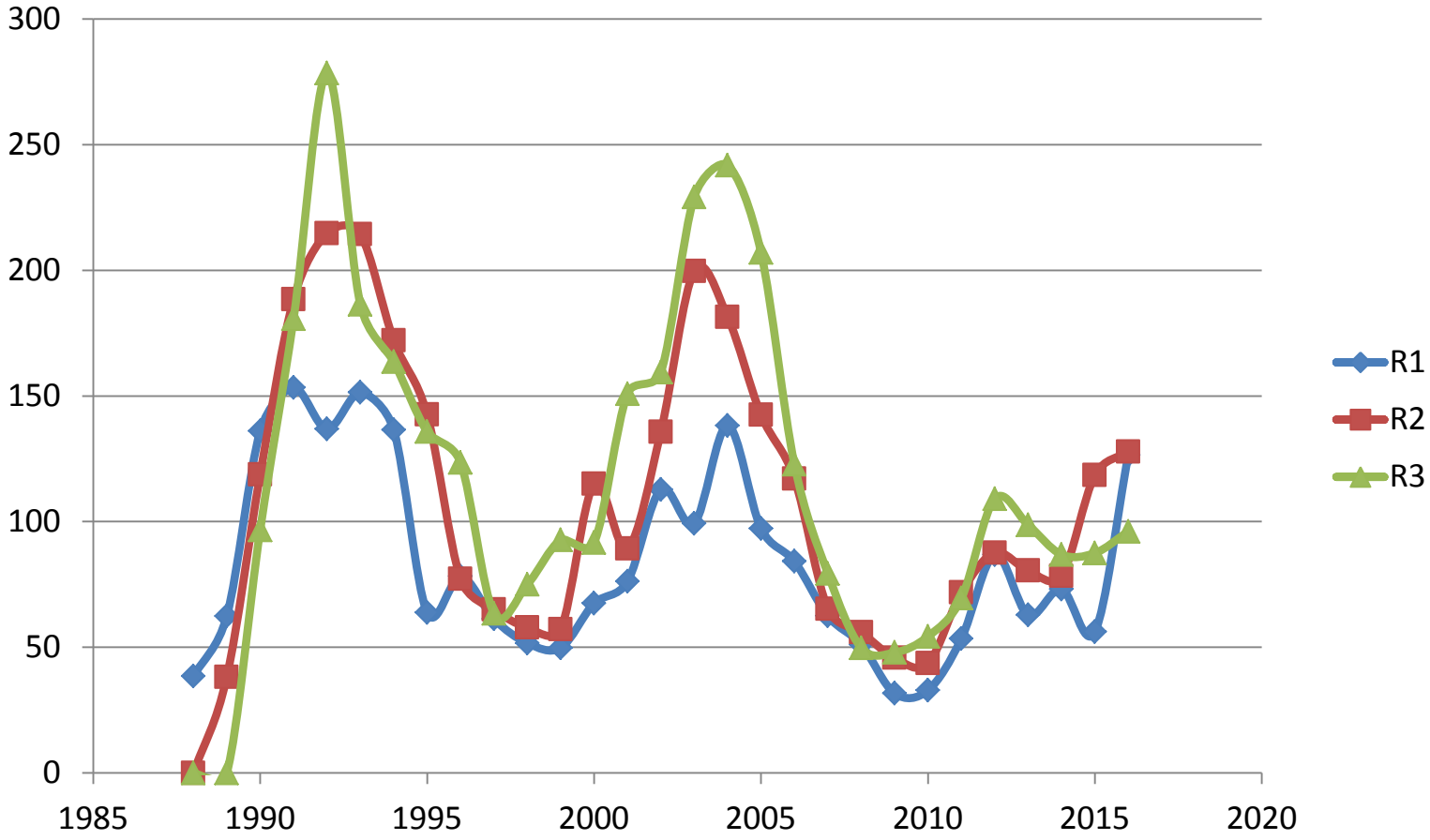
R1 (recruitment 1 year prior to entering fishery- Male mature gt 95mm)
R2 (recruitment 2 years prior to entering fishery- Male immature gt 83mm)
R3 (recruitment 3 year prior to entering fishery- Male immature gt 63mm)

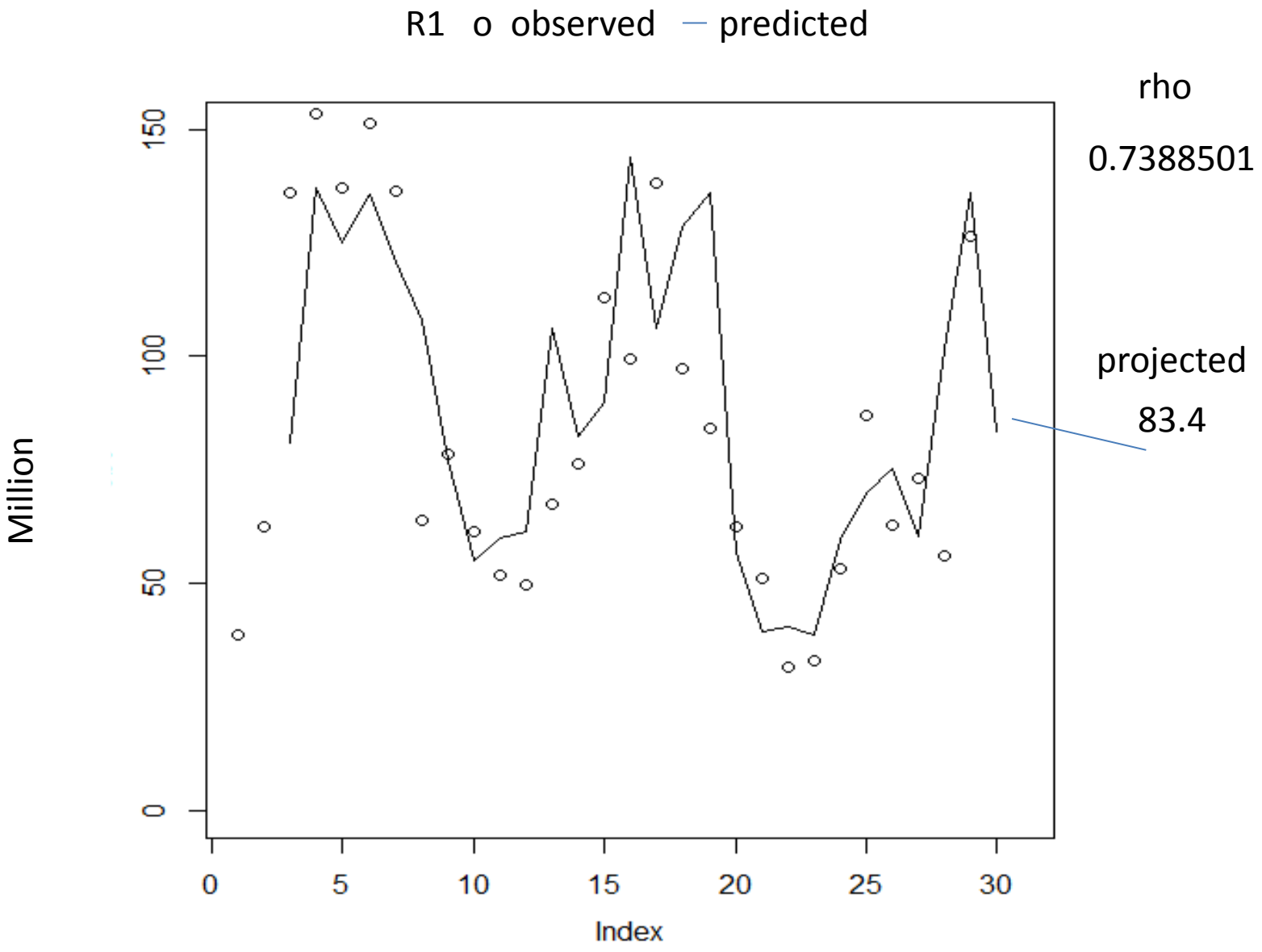


R1 from survey at year Y

R2 from survey at year Y-1 …. shown offset to match with year Y

R3 from survey at year Y-2 …. shown offset to match with year Y




R1 o observed — predicted
rho
0.7388501
projected
83.4
Million
0
50
100
150
0
5
10
15
20
25
30
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Example code

```
> data("two_species_model")
> ts <- two_species_model$x[1:200]
> out = simplex(ts, lib = c(1, 100),
                                    pred=c(101,200))

> head(round(out, dig=4))
  E tau tp nn num_pred    rho    mae
1 1   1  1  2       99 0.9977 0.0084
2 2   1  1  3       98 0.9989 0.0051
3 3   1  1  4       97 0.9991 0.0050
4 4   1  1  5       96 0.9972 0.0081
5 5   1  1  6       95 0.9965 0.0095
6 6   1  1  7       94 0.9949 0.0127
```

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5 5   1  1  6       95 0.9965 0.0095
6 6   1  1  7       94 0.9949 0.0127
```

Easy to know ‘enough to be dangerous’.

Recommendations

1. Worth continuing to understand – do more with simulated data.

2. Seems to be capturing some underlying dynamics in salmon (with updated data).

3. Does require a firm understanding of environmental mechanisms (don’t jump to conclusions).