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ADDENDUM TO SCRS/93/51. MODIFICATION TO THE LSSPA STOCK ASSESSMENT MODEL

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SUMMARY

Modifications to the LSSPA model presented in SCRS/93/51 are made which result in more accurate estimates of stock size and fishing mortality rates. Biases in estimates of F and N for the simulated data fit with the model in SCRS/94/63 are found to be negligible after implementing this modification to the model formulation.

RESUME

Les changements dans le modèle LSSPA qui avait été présenté dans le document SCRS/93/51, ont été pris en compte et donnent des estimations plus précises de la taille du stock et des taux de mortalité par pêche. Les biais dans les estimations de F et de N pour les données simulées ajustées au modèle dans le document SCRS/94/63 sont jugés négligeables après introduit ces changements dans la formulation du modèle.

RESUMEN

Se introducen modificaciones en el modelo LSSPA presentado en el SCRS/93/51, que resultan en estimaciones más precisas del tamaño del stock y tasas de mortalidad por pesca. Se halla que los sesgos en las estimaciones de F y N para los datos simulados ajustados al modelo en el SCRS/94/63 son despreciables tras implementar esta modificación a la formulación del modelo.

ADDENDUM TO SCRS/93/51

Modifications to the LSSPA Stock Assessment Model

In SCRS/93/51 and SCRS/94/63, we fit the LSSPA model by minimizing:

$$\Sigma[\ln(c_{gik}) - \ln(\hat{c}_{gik})]^2 + \Sigma[\ln(cpue_{gik}) - \ln(\hat{q}_g \hat{f}_{gik})]^2,$$

where:
c_{gik} = the catch in numbers of gear g in year i of length k,
f_{ik} = the total population numbers in year i of length k,
s_{gk} = the selectivity of gear g at length k,
$f_{gik} = f_{ik} s_{gk}$,
$cpue_{gik}$ = the catch per unit effort from the fishery using gear g in year i at length k.

LSSPA runs (SCRS/94/63) using test datasets presented in SCRS/93/17 showed that the LSSPA model gave biased results.

We feel the reasons for this were twofold:

1. The logs of small observations may give large residuals on the log-scale. Subsequently they are given a large weighting in the least squares fit.

2. The second term in the least squares fit is generally biased. In this term we assumed catch per unit effort is proportional to abundance, which is not a bad assumption if abundance is average abundance during the year. However, in the test datasets, and generally in datasets where cpue are fishery-based, we should adjust the annual initial population size by an expression that generally looks like: $\frac{1}{Z}(1-\exp(-Z))$, then $\frac{N}{Z}(1-\exp(-Z)) \approx \frac{C}{F}$. In the LSSPA model, this must be done by length category.

Let $F_{ik} = \sum_g s_{gk} F_{gi}$ be the total instantaneous fishing mortality in year i at length k, and $u_{gik} = \frac{s_{gk}}{M + F_{ik}}(1 - \exp(-M - F_{ik}))$. We currently recommend parameter estimation for LSSPA by minimizing the sum of absolute deviations:

$$\Sigma\left|\ln(c_{gik}) - \ln(\hat{c}_{gik})\right| + \Sigma\left|\ln(cpue_{gik}) - \ln(\hat{q}_g \hat{u}_{gik} \hat{f}_{ik})\right|.$$

Alternatively, robust regression methods can be used.

Using methods provided in this addendum gives much improved model performance over that in SCRS/94/63 on simulated datasets (Fig.1).

1. Test dataset 1, HC_BM.
Output variables: yr, recr, f by fish, ftot, totn, totb.

1	95	0.105	0.105	428	45169
2	104	0.121	0.121	418	42768
3	482	0.135	0.135	788	44615
4	128	0.154	0.154	730	53578
5	87	0.183	0.183	628	60192
6	111	0.198	0.198	554	59292
7	81	0.219	0.219	467	54133
8	124	0.239	0.239	444	47092
9	284	0.258	0.258	589	42803
10	90	0.282	0.282	511	42819
11	95	0.299	0.299	443	41363
12	80	0.326	0.326	371	37072
13	87	0.343	0.343	321	30033
14	86	0.360	0.360	294	25953
15	109	0.363	0.363	301	23170

2. Test dataset 2, HC_CM.
Output variables: yr, recr, f by fish, ftot, totn, totb.

1	99	0.100	0.100	442	47038
2	102	0.112	0.112	427	44684
3	504	0.137	0.137	818	46686
4	121	0.153	0.153	746	55567
5	87	0.170	0.170	639	62083
6	111	0.190	0.190	564	61195
7	80	0.209	0.209	475	55474
8	124	0.232	0.232	450	48334
9	296	0.253	0.253	607	44102
10	84	0.274	0.274	518	44047
11	96	0.294	0.294	449	42544
12	78	0.312	0.312	373	37820
13	84	0.333	0.333	320	30510
14	78	0.356	0.356	286	26216
15	94	0.378	0.378	280	22902

3. Test dataset 3, LC_BM.
Output variables: yr, recr, f by fish, ftot, totn, totb.

1	93	0.105	0.105	431	46064
2	101	0.104	0.104	416	43411
3	99	0.108	0.108	407	41713
4	113	0.114	0.114	415	40877
5	88	0.119	0.119	398	40501
6	106	0.124	0.124	401	40024
7	81	0.130	0.130	378	39256
8	122	0.135	0.135	399	37928
9	99	0.141	0.141	391	37063
10	83	0.145	0.145	370	36699
11	94	0.150	0.150	364	35882
12	78	0.157	0.157	342	34643
13	85	0.161	0.161	332	33153
14	72	0.168	0.168	311	31438
15	101	0.173	0.173	325	30150

4. Test dataset 4, LC_CM..
Output variables: yr, recr, f by fish, ftot, totn, totb.

1	98	0.100	0.100	418	41617
2	102	0.105	0.105	404	38921
3	101	0.109	0.109	405	40165
4	118	0.113	0.113	426	41680
5	86	0.115	0.115	409	42747
6	110	0.121	0.121	419	43185
7	80	0.127	0.127	379	39042
8	125	0.133	0.133	403	38325
9	101	0.138	0.138	398	37831
10	82	0.143	0.143	375	37386
11	95	0.150	0.150	368	36441
12	77	0.154	0.154	345	35078
13	84	0.160	0.160	333	33513
14	77	0.166	0.166	316	31660
15	92	0.174	0.174	320	30359

Figures

Fig. 1. Least absolute deviation fits to the four simulation datasets using model corrections provided in this addendum. Comparisons are made using known 1 yr-old recruitment, and known total 1-10 yr-old population numbers.