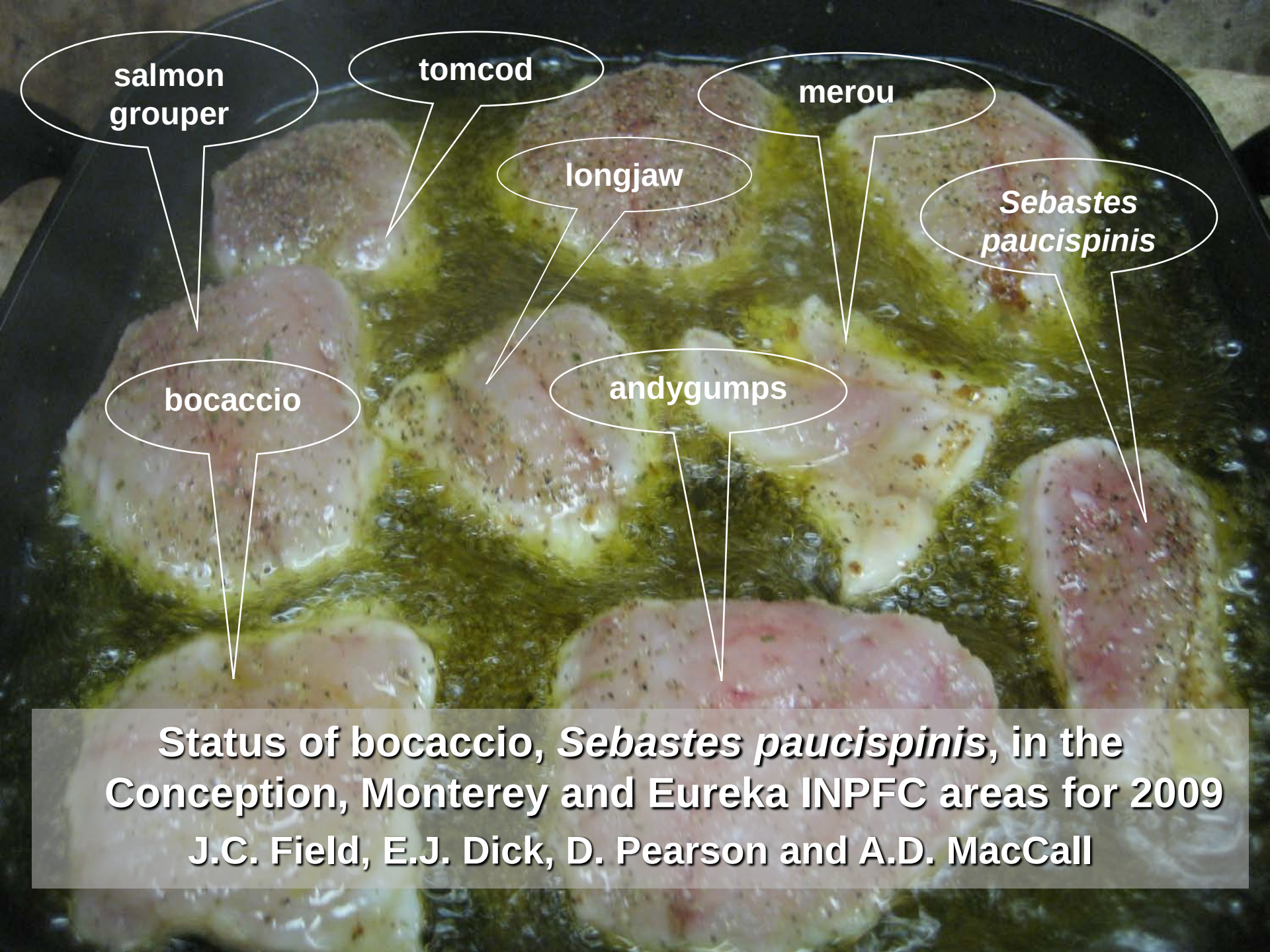
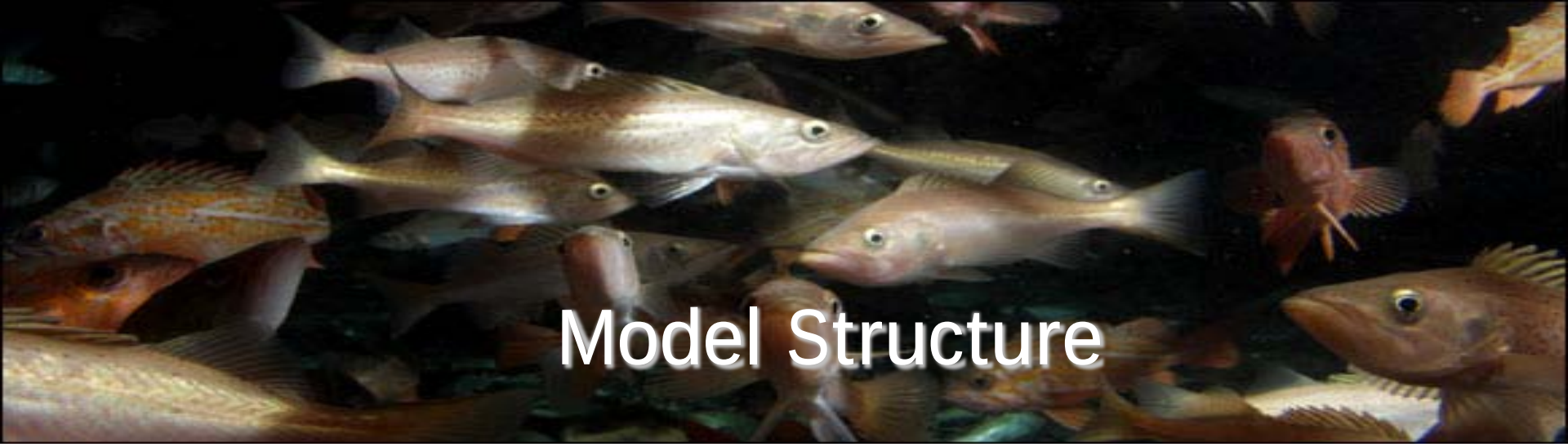


Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterey and Eureka INPFC areas for 2009

J.C. Field, E.J. Dick, D. Pearson and A.D. MacCall

General overview

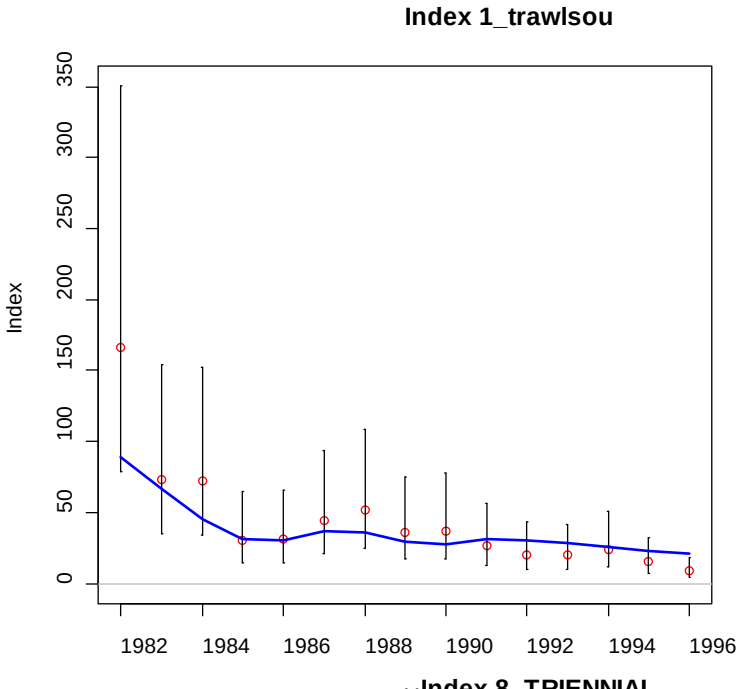
- Last full assessment was 2003, updated in 2005, 2007
- Major changes include
  - Movement to SS3 (v3.03a) from SS1 (an SS2 bypass)
  - Greatly revised catch history and extension of period modeled
  - Revise triennial survey estimate using a GLMM
  - Addition of NWFSC combined trawl survey. SCB hook and line survey, revised juvenile indices (Pier index and juvenile trawl survey index)
- Spatial structure only moderately changed from the past (from Mendocino to Blanco), fleet structure similar (difference is two trawl fisheries rather than one)
- Model seems to behave reasonably well, much faster run times than SS1 models, although likelihood surface can still be somewhat irregular.
- Base run resulting trend highly similar to 2007 model for recent (historical) period, but revised catch history scales depletion.
- Stock structure remains an unresolved problem and a major uncertainty, particularly with respect to the status of bocaccio north of Cape Blanco

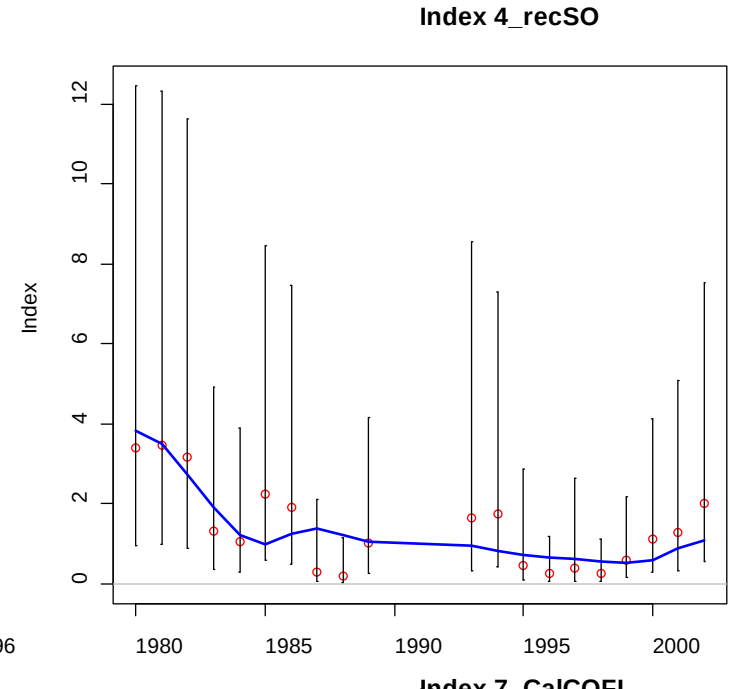


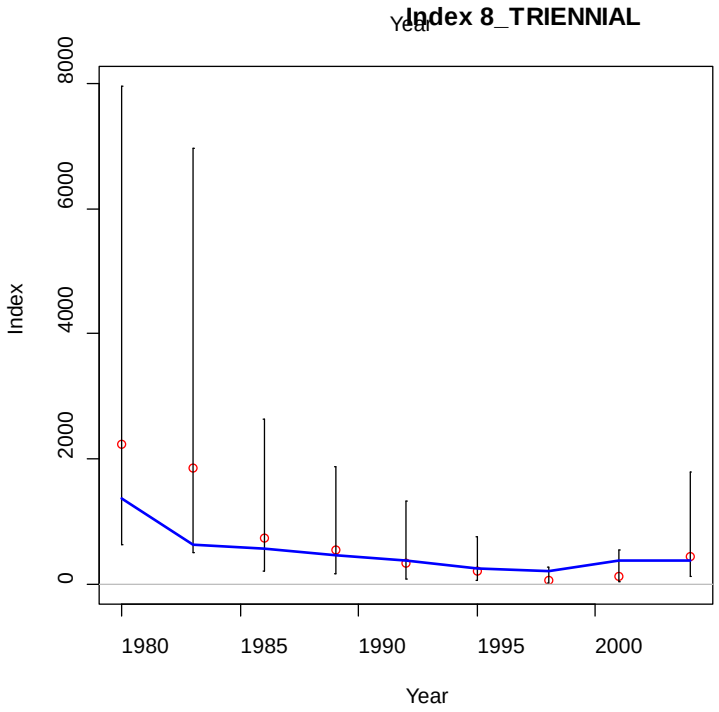
Model Structure

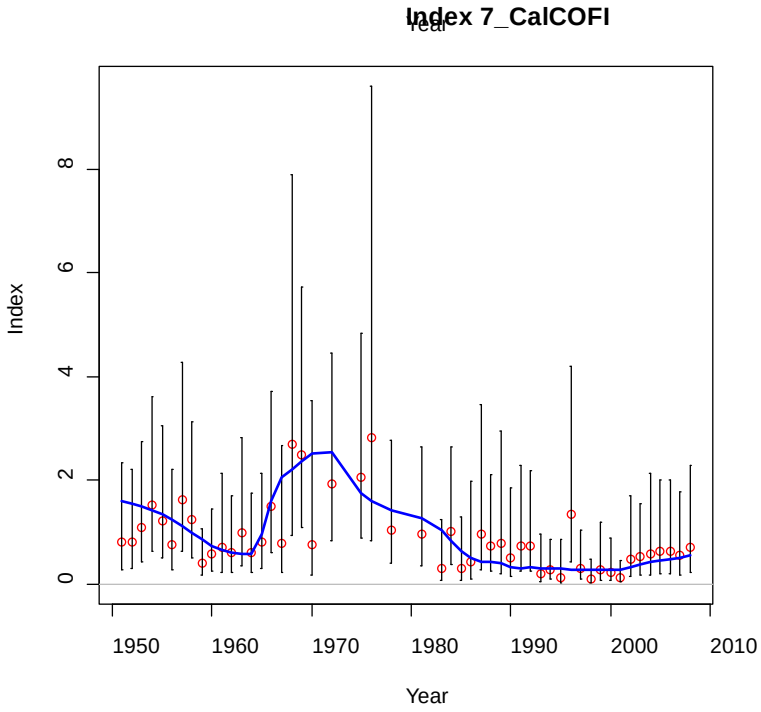
- Begin model in 1892 with initial catch based on average of early catch estimates, six fishing fleets (two trawl, southern and northern, hook and line, setnet, recreational south and north). Revised catch history has ~500 tons in 1950, versus 2000 in 2003 model.
- Steepness estimated with prior (prior is 0.74, posterior 0.57)
- Two-sex, single area model, natural mortality fixed at 0.15, new maturity function, growth estimated (except L_{min}), new fecundity, accumulator age 21
- Recruitment deviations estimated 1954 to 2008, sigma-R fixed at 1 (effective ~1.1)
- All catchability coefficients are treated as nuisance parameters (assumed proportional)
- Selectivity curves are a mix of asymptotic and dome-shaped (double normal), based on fit to data (clear rationale for dome for some fisheries, less clear for others), some parameters had to be fixed due to convergence problems (triennial, southern trawl)
- Indices and effective sample sizes tuned (downweighting, but not upweighting), no weighting on lambdas in base model, weighting used for capturing uncertainty

Four of the key indices in this assessment, trawl CPUE, triennial trawl survey, southern recreational CPUE, and the CalCOFI larval abundance index

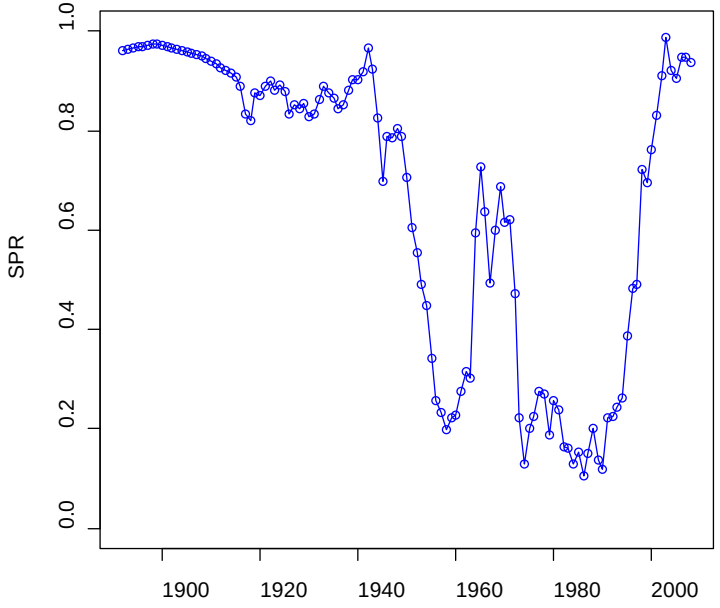








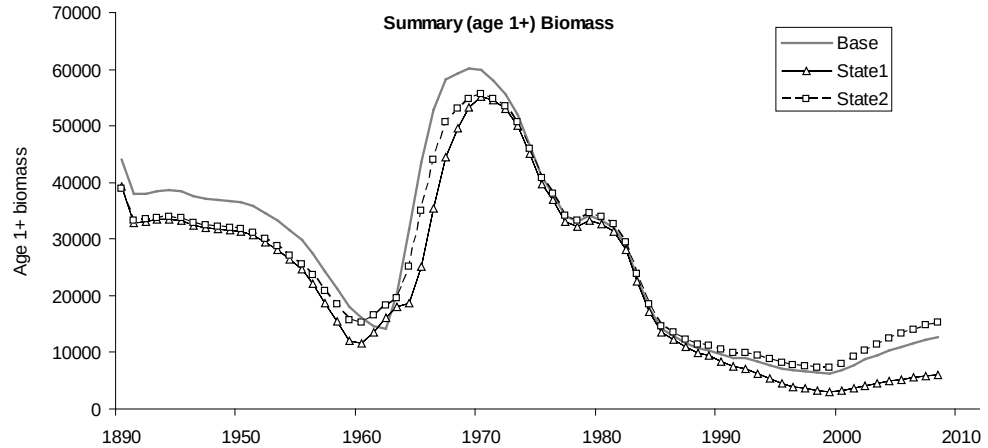
Base model estimates modest depletion from init until 1950, spike in abundance during the 1960s, followed by a very steep decline through the 1970s and 1980s. Since the 1999 year class (and moderate 2003, 2005 year classes), biomass has slowly increased, 2009 estimated depletion is 28% of SSB_0

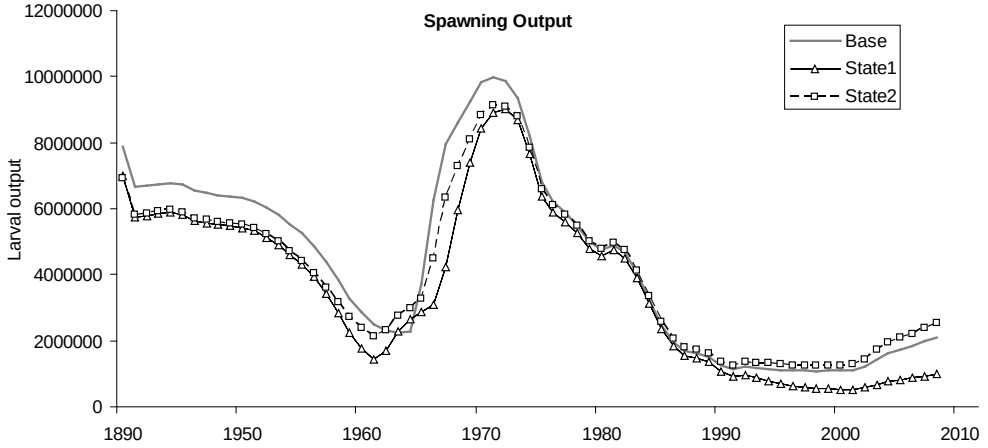


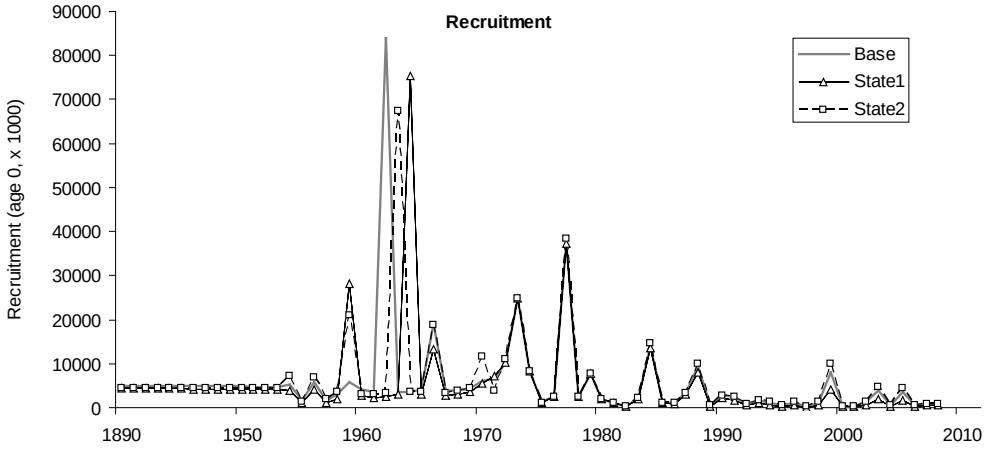
Major sources of uncertainty in the model relate to the tension between two pessimistic indices (trawl CPUE, triennial survey) and two optimistic indices (southern recreational CPUE and CalCOFI larval abundance).

The two alternative states of nature sequentially increased the emphasis on each of these groups to bracket uncertainty. These scenarios also provided useful contrast between an apparent, but poorly understood, spatial dimension - data suggest that recovery may be taking place more rapidly in the south.

Recovery in the central/northern region may be dependent on an influx of fish from the southern area, although movement/diffusion processes are poorly understood.







Research Needs and Management Concerns

Research needs

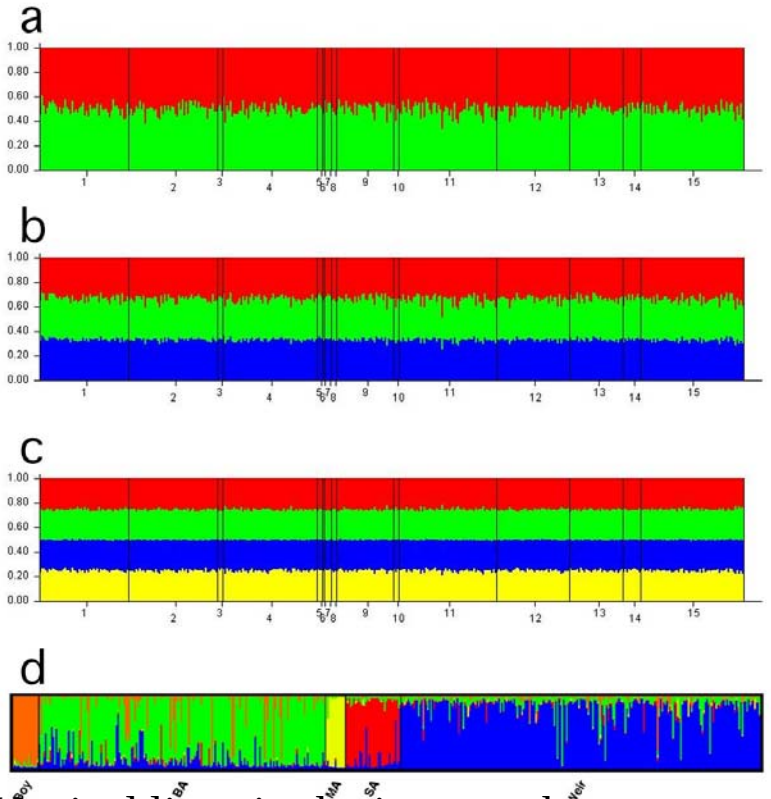
- Stock structure is a key uncertainty, particularly with respect to how best to assess abundance or trends north of Blanco
- May be some potential to explore area models, although diffusion or migration patterns and rates will not be well informed
- Ongoing efforts to retrospectively analyze CalCOFI samples from the northern stations collected in the 1950s and 1960s should help in long term
- Development of defensible ageing criteria for bocaccio in the southern area would be beneficial (but challenging)
- Trawl surveys are not well suited to this species, improved survey methodologies would be helpful
- Area closures are impacting distribution of fishing effort, leading to possible problems with some surveys

Management Concerns

- The decision to extend the boundaries of the southern subpopulation was based on the observation that catches (both fishery and survey-derived) do not end abruptly at Cape Mendocino, but rather tend to taper off to the north. As such the fish in this region were more likely to originate from the southern subpopulation than the subpopulation distributed to the north. Either boundary is imperfect.
- The vast majority of the catches and data are derived from the region south of Cape Mendocino. Thus, it would be reasonable to apply (or scale) the results of this assessment to management measures applied to bocaccio solely in this region - practical considerations could preclude the application of these results by management to the small part of the northern range

Stock Structure

- A key uncertainty in this assessment, northern area is very data poor, not modeled.
- Stock has historically been assessed only in the southern area, based on a conceptual model of northern (BC Can, PNW) and southern (CA, BC Mex) population centers
- Past assessments suggested stock structure between CA and OR/WA/BC, but mixing between S. Cal. and Monterey Bay. Matala et al. (2004) suggested population structure related to geographic location throughout the CCS, however a reanalysis (D. Pearse/SWFSC) indicates no genetic separation
- However, there is evidence of demographic independence north/south, differences in growth, maturity, longevity (northern fish grow slower, mature at greater sizes, live longer)
- Additionally, there is a proposed rule to list a separate DPS for the Georgia Basin as endangered under the ESA

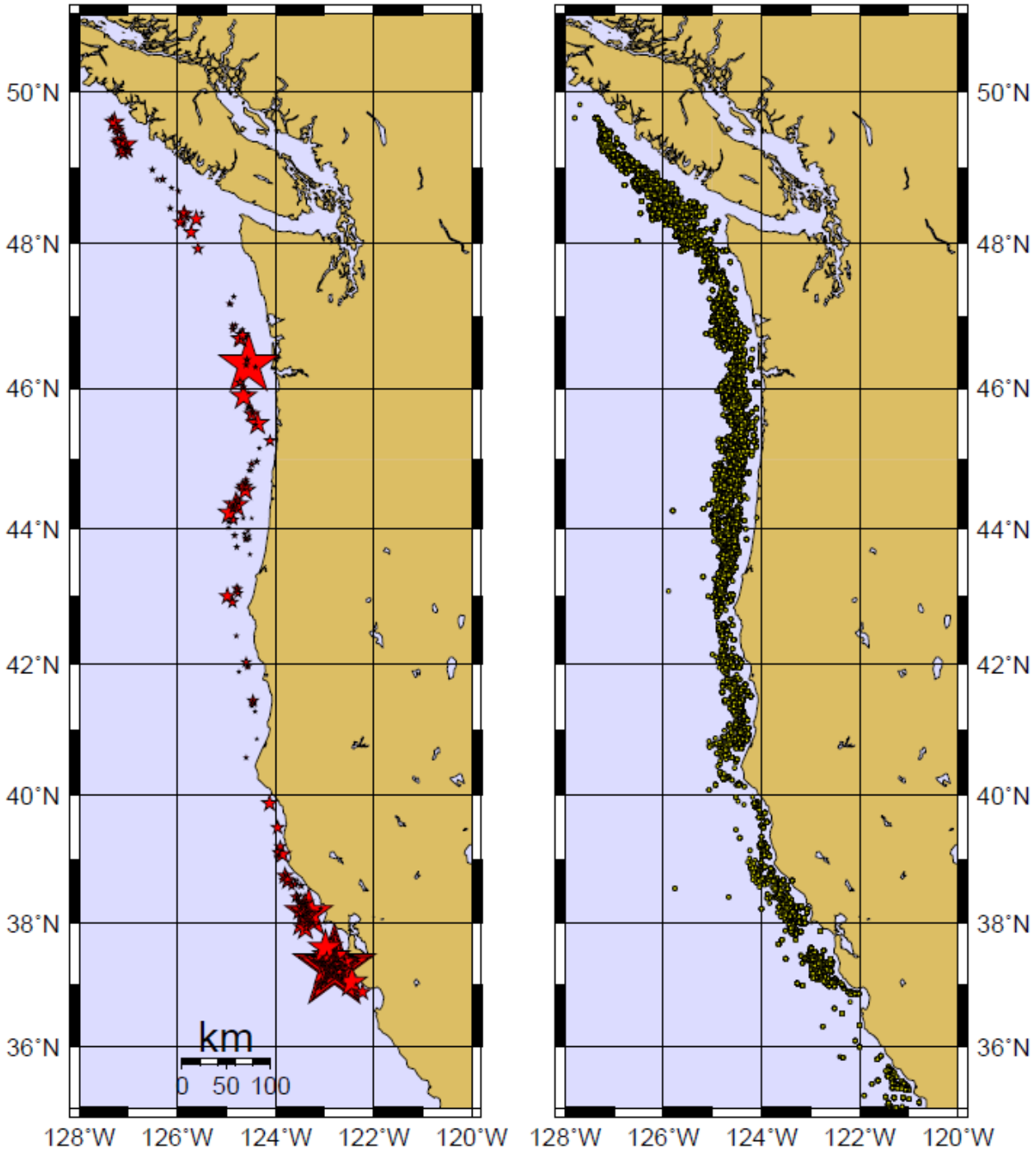


Vertical lines in the images above represent individuals, colors represent the probability of membership into distinct groups. Top three panels show bocaccio data from Matala et al., bottom panel shows analysis of genetically-distinct steelhead population (e.g., what structure would look like).

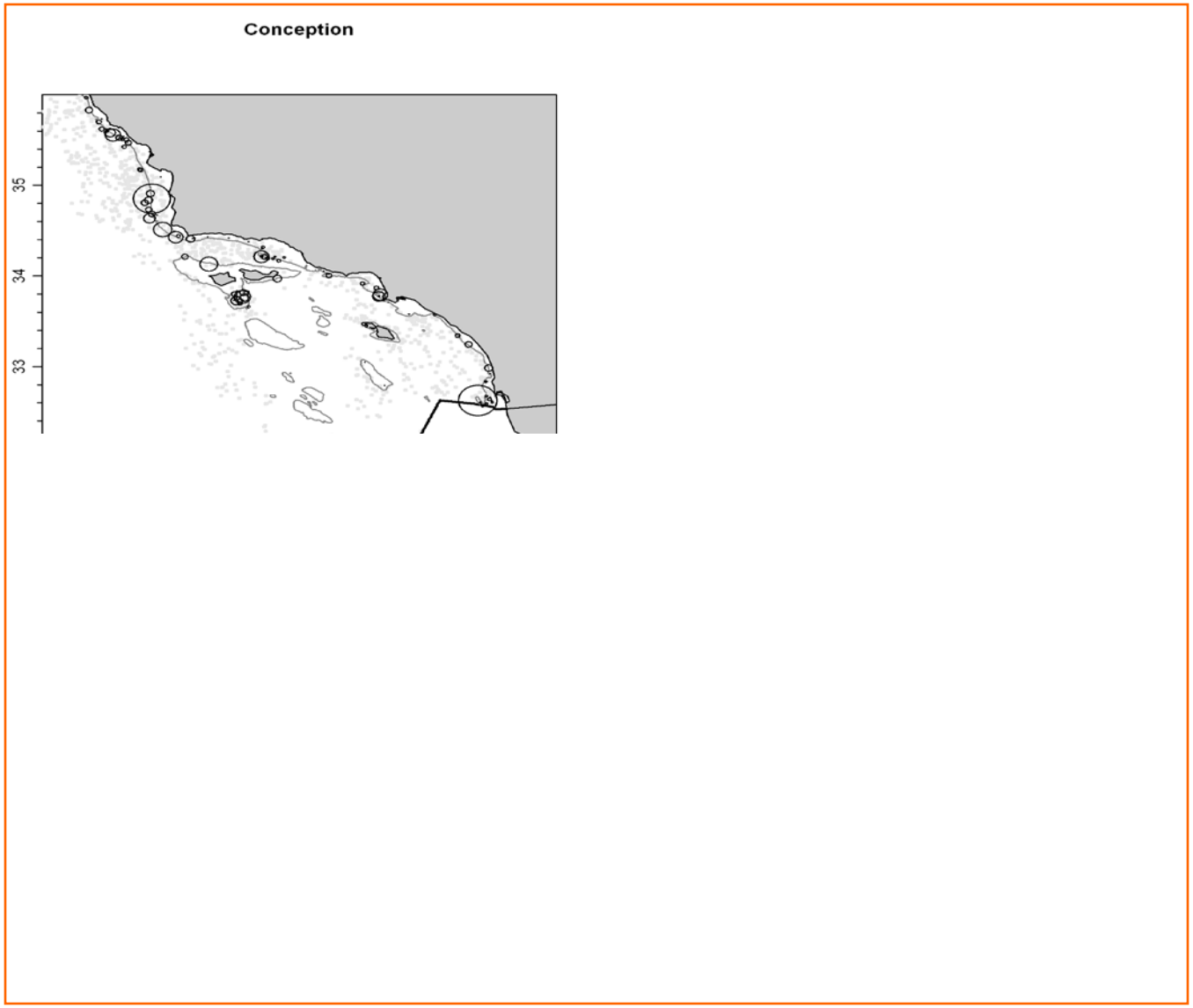
Russian fishery catches (1966-1976), bocaccio catch at left, total tows at right

Assessment area has historically been the region of highest abundance, south of Mendocino (where bocaccio represent 20-30% of all catches)

In Oregon and Washington, bocaccio were ~1-3% of all , in Canada up to 4-7%.

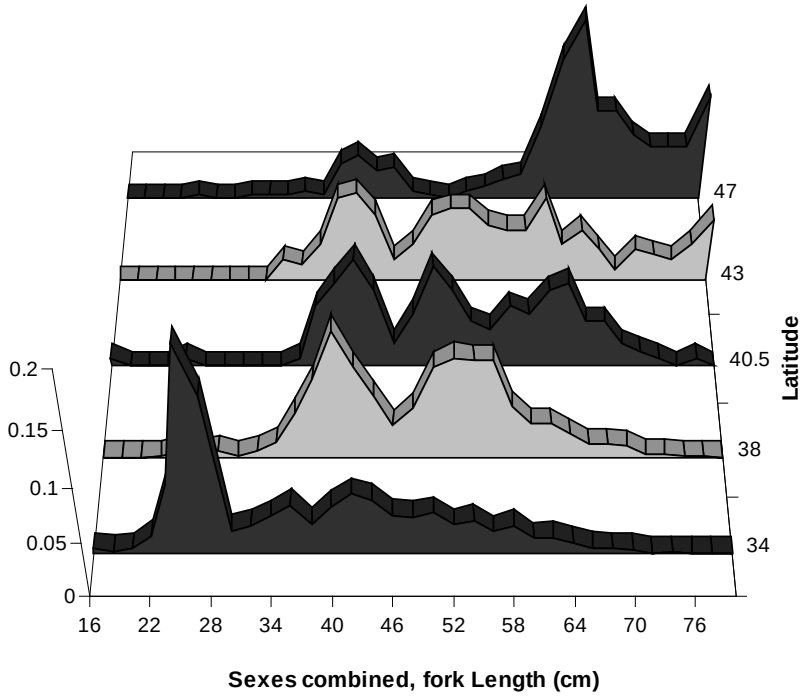


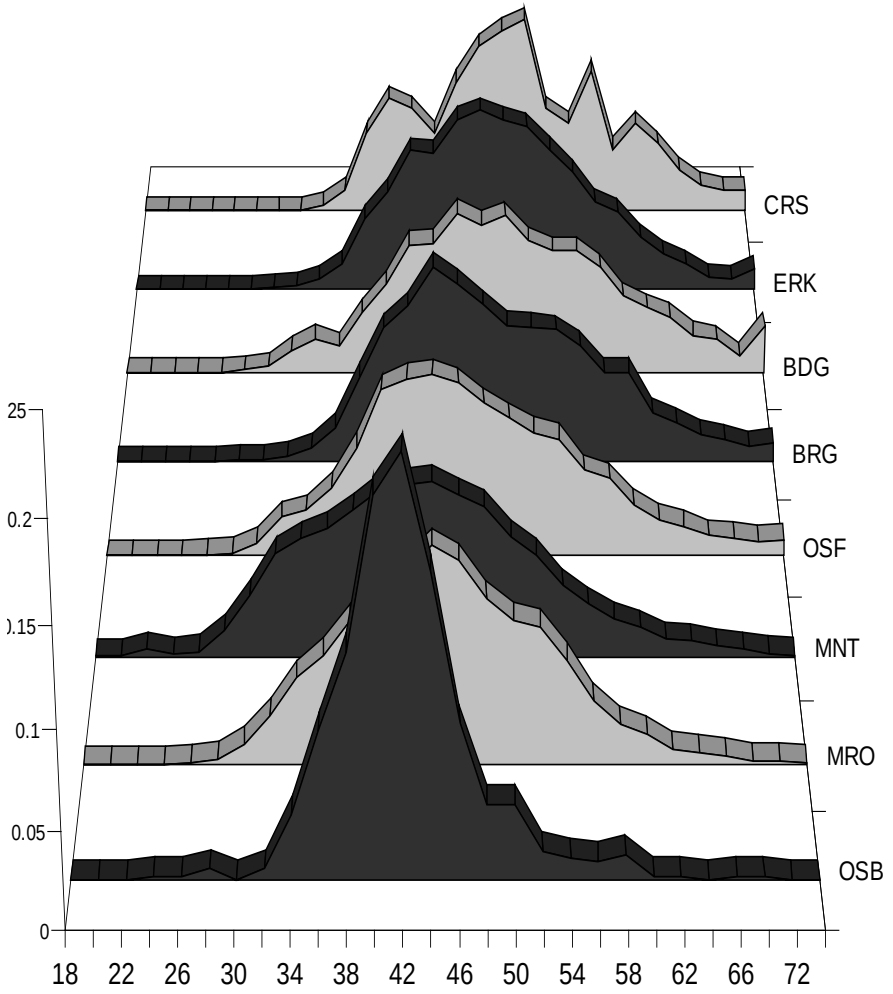
Triennial trawl survey CPUE (1980-2004)



NWFSC Combined trawl survey CPUE (2003-2008)

Diffusion of large fish to the north?





Very small fish are typically seen only in South/central California (as far as Monterey), usually in pier fisheries – larger fish increase in FO to north.

These two scenarios formed the basis for the decision table (State 1 upweights trawl CPUE and triennial survey, State 2 upweights southern rec. CPUE and CalCOFI index).

Alternative catch streams based on observed recent catches (low scenario), catches based on the rebuilding plan SPR rate (0.77, base scenario), and catches based on SPR of 0.77 with the optimistic model (high scenario).

Even the pessimistic model with the high catch scenario predicts an increase (albeit modest) in spawning output

		State1 (low biomass)		Base Model		State2(high biomass)	
catch with 2008 F		larvae	depletion	larvae	depletion	larvae	depletion
2009	65	1034540	**0.15**	2209950	**0.28**	2658620	**0.38**
2010	62	1056130	**0.15**	2259880	**0.29**	2715680	**0.39**
2011	62	1059020	**0.15**	2267600	**0.29**	2720120	**0.39**
2012	68	1076100	**0.15**	2289230	**0.29**	2736480	**0.40**
2013	78	1133840	**0.16**	2371870	**0.30**	2819550	**0.41**
2014	90	1224880	**0.18**	2506410	**0.32**	2959720	**0.43**
2015	102	1337490	**0.19**	2675120	**0.34**	3137450	**0.45**
2016	113	1464190	**0.21**	2865660	**0.36**	3338590	**0.48**
2017	123	1600700	**0.23**	3069460	**0.39**	3552450	**0.51**
2018	129	1744400	**0.25**	3280130	**0.42**	3770470	**0.55**
2019	136	1893960	**0.27**	3493470	**0.44**	3986640	**0.58**
2020	142	2048240	**0.29**	3706040	**0.47**	4196180	**0.61**
SPR 0.77 (base)		larvae	depletion	larvae	depletion	larvae	depletion
2009	267	1034540	**0.15**	2209950	**0.28**	2658620	**0.38**
2010	251	1025030	**0.15**	2228890	**0.28**	2684700	**0.39**
2011	246	997328	**0.14**	2206150	**0.28**	2658730	**0.38**
2012	265	986019	**0.14**	2199380	**0.28**	2646800	**0.38**
2013	299	1013570	**0.14**	2252490	**0.29**	2700770	**0.39**
2014	339	1068090	**0.15**	2352740	**0.30**	2807790	**0.41**
2015	377	1136160	**0.16**	2481040	**0.32**	2947220	**0.43**
2016	413	1210440	**0.17**	2625210	**0.33**	3105210	**0.45**
2017	445	1287560	**0.18**	2777630	**0.35**	3272010	**0.47**
2018	474	1365920	**0.20**	2933000	**0.37**	3440210	**0.50**
2019	500	1444790	**0.21**	3087910	**0.39**	3604600	**0.52**
2020	517	1523620	**0.22**	3239680	**0.41**	3761180	**0.54**
SPR 0.77(State 2)		larvae	depletion	larvae	depletion	larvae	depletion
2009	353	1034540	**0.15**	2209950	**0.28**	2658620	**0.38**
2010	326	1009690	**0.14**	2213630	**0.28**	2669450	**0.39**
2011	314	967342	**0.14**	2176350	**0.28**	2628970	**0.38**
2012	328	942839	**0.13**	2156410	**0.27**	2603940	**0.38**
2013	360	956879	**0.14**	2196410	**0.28**	2645010	**0.38**
2014	395	995845	**0.14**	2282340	**0.29**	2738290	**0.40**
2015	429	1045960	**0.15**	2394880	**0.30**	2863010	**0.41**
2016	459	1100950	**0.16**	2522930	**0.32**	3006440	**0.43**
2017	479	1158410	**0.17**	2659810	**0.34**	3159810	**0.46**
2018	497	1217370	**0.17**	2800930	**0.36**	3316360	**0.48**
2019	512	1277570	**0.18**	2943370	**0.37**	3471380	**0.50**
2020	527	1338790	**0.19**	3084810	**0.39**	3621160	**0.52**