


Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

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RISK ANALYSIS FOR BIGEYE TUNA, 2019: hypotheses and models

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Issues with EPO tropical tuna stock assessments

- Management advice based on a “best assessment” approach
- *F* multiplier from the YFT and BET base case assessments used to determine the duration of the seasonal closure
- 2018: BET assessment model not reliable enough to determine closure (SAC-09 INF)
  - Assessment overly sensitive to new data (mainly for the indices of abundance from the longline fishery)
  - Other issues
- 2019: same conclusion extended to YFT assessment (SAC-10 INF-F)

2018-2020: Workplan to improve the stock assessments of tropical tuna

- Included external reviews of the YFT and BET assessments
- Both external reviews suggested a variety of alternative models rather than a replacement for base case
- Change from “best assessment” to a risk analysis approach which considers multiple models and explicitly deals with stock assessment uncertainty

The staff's pragmatic risk analysis approach

Described in Maunder et al. 2020 (SAC-11- INF-F):

1. **Identify alternative hypotheses** ('*states of nature*') about the population dynamics of the stock that address the main issues in the assessments
   - YFT: SAC-11-J; BET: SAC-11 INF-F
2. **Implement stock assessment models representing alternative hypotheses**
   - YFT: SAC-11-07; BET: SAC-11-06
3. **Assign relative weights to each hypothesis (model)**
   - YFT: SAC-11 INF-J; BET: SAC-11 INF-F
4. **Compute combined probability distributions for management quantities using model relative weights**
   - SAC-11-08

Introduction

Old framework for management advice:

"*Base-case*" assessment based on the "best" model

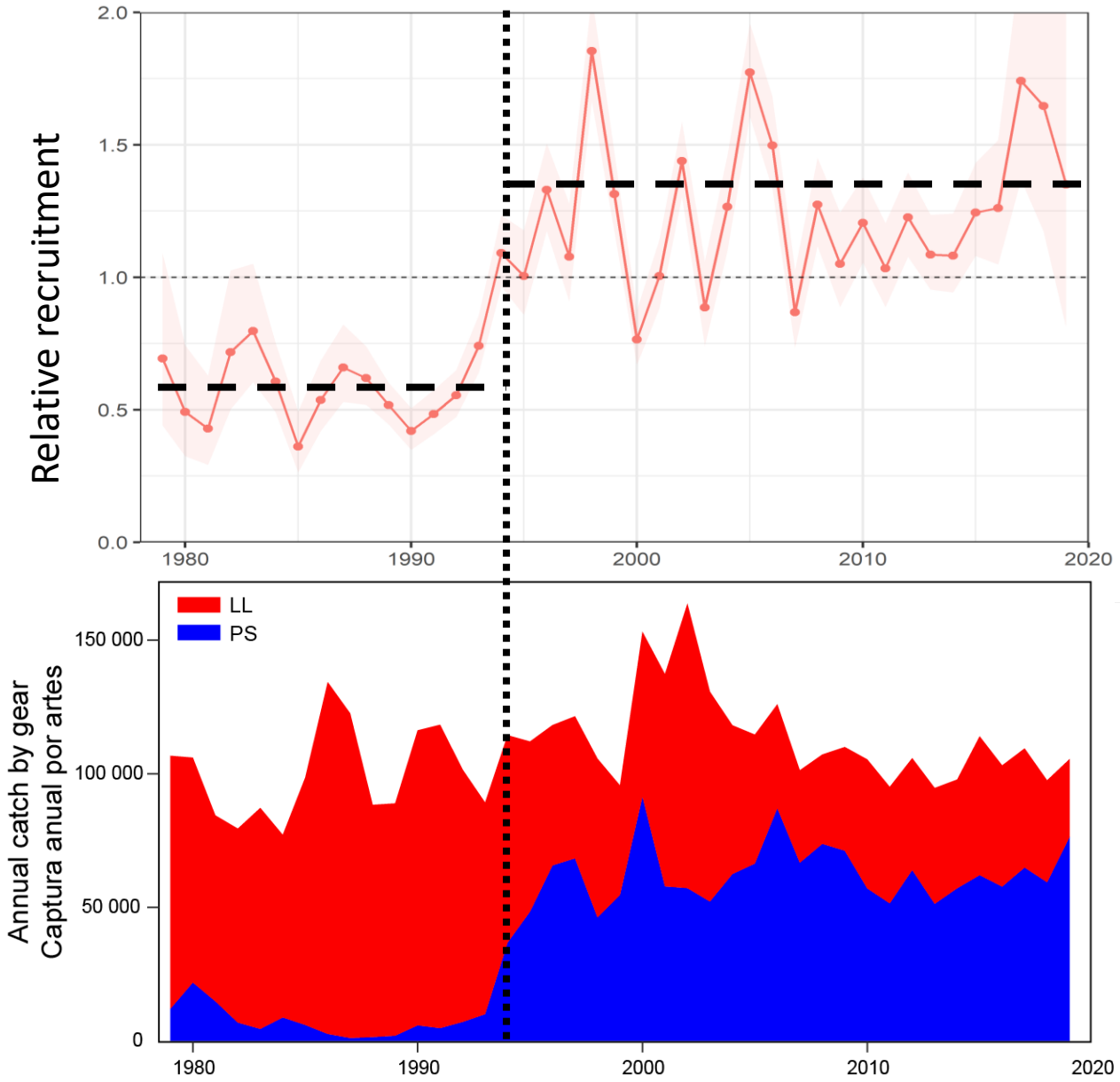
New framework for management advice:

Risk analysis based on hypothesis-driven models that represent alternative states of nature

hypotheses regarding two key assessment issues are developed within a hierarchical framework:

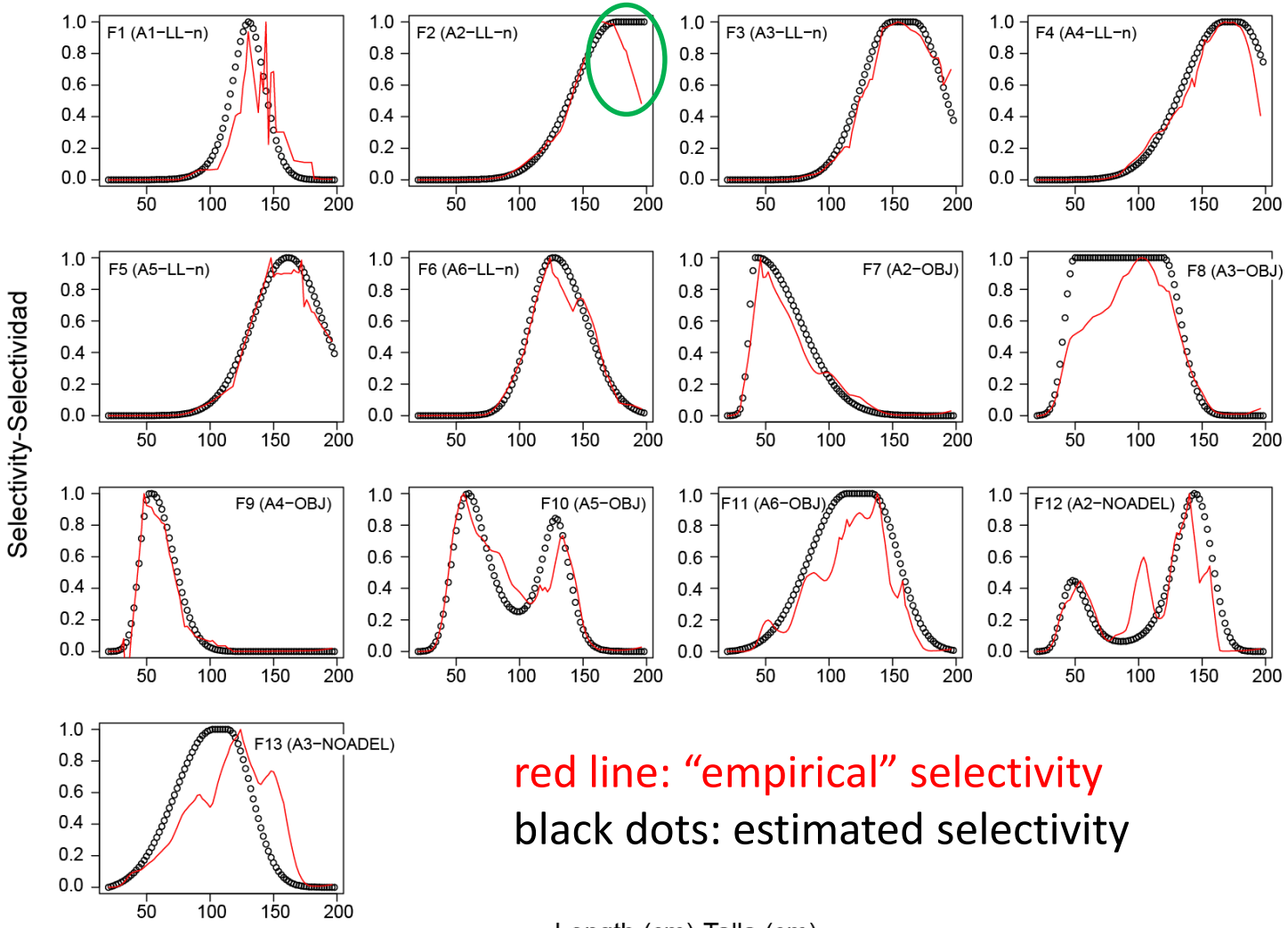
1. Regime shift in recruitment
2. The poor fit to longline length composition data

Issues in previous assessments: recruitment shift



Issue 1: The regime shift in recruitment occurred when the OBJ fishery started to expand in the EPO

Issues in previous assessments: longline selectivity

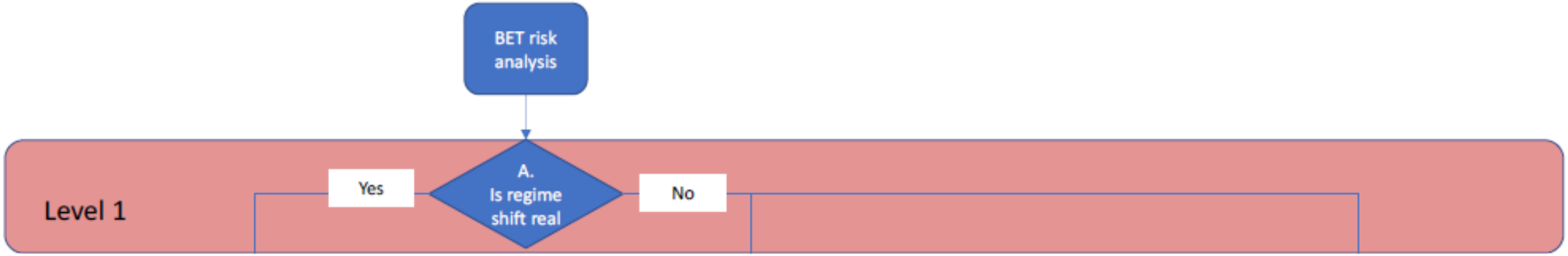


red line: "empirical" selectivity

black dots: estimated selectivity

Issue 2: for the longline fishery which is assumed to have asymptotic selectivity (Fishery 2), the composition data does not fit well to the model at large sizes

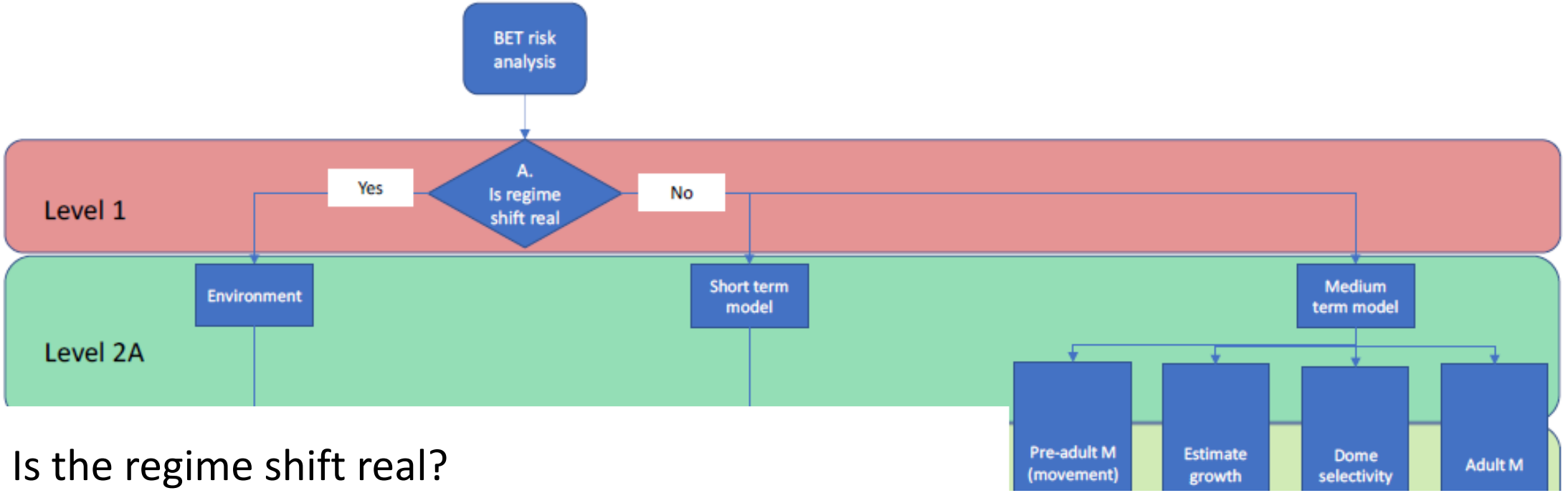
Level 1 hypotheses



Is the regime shift real?

- **Yes**: Environmental/ecosystem changes around 1993 increased the productivity of bigeye in the EPO
- **No**: model mis-specification causes the regime shift

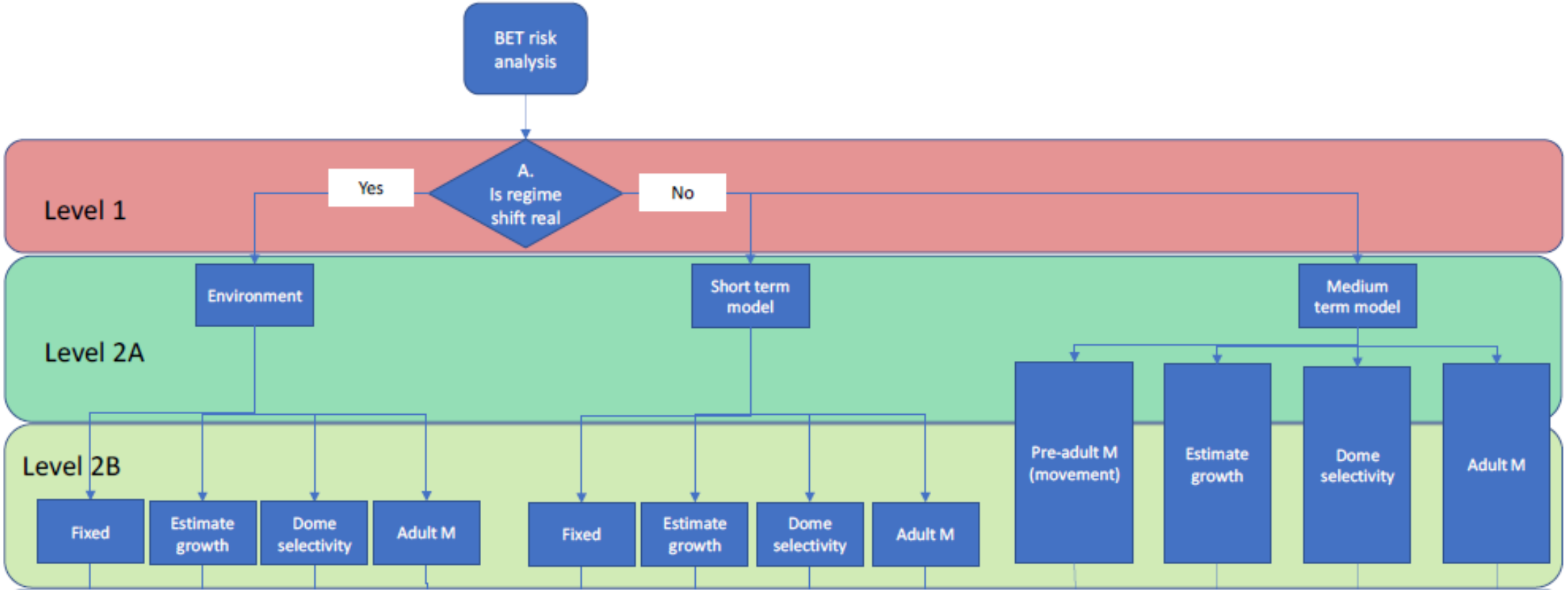
Level 2A hypotheses



Is the regime shift real?

- Yes: Environmental/ecosystem changes around 1993 increased the productivity of bigeye in the EPO
  - **Environment** – estimate a recruitment regime parameter for 1979-1993
  - **Ecosystem** (not shown) – Use the Ricker stock-recruit relationship
- No: model mis-specification causes the regime shift
  - The mis-specified process is unknown (**short term model** – 2000-2019)
  - One process is mis-specified (**medium term model** – 1979-2019): movement, growth, selectivity, natural mortality, index of abundance (not shown)

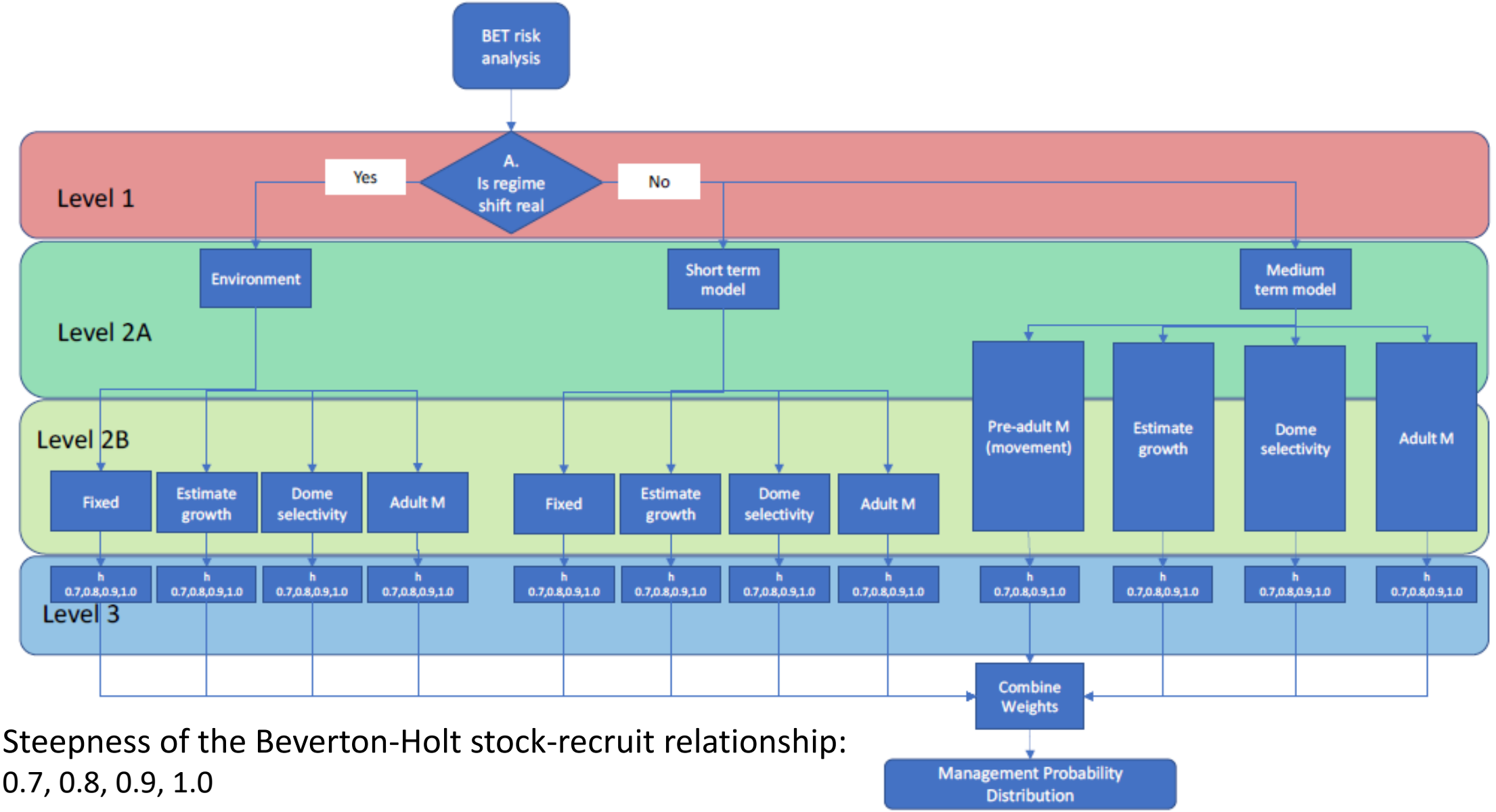
Level 2B hypotheses



Hypotheses for the poor fit of longline compositions

- Random error in observations (**Fixed** – fix growth and natural mortality)
- Growth is mis-specified (**Estimate growth** – estimate the Richards growth curve and its variability)
- Longline selectivity is dome-shaped (**Dome selectivity** – use the double-normal selectivity curve)
- Adult natural mortality is mis-specified (**Adult M** – estimate the natural mortality of age 26+ quarters)
- longline compositions are unrepresentative (not shown) – down-weight longline compositions

Level 3 hypotheses



Steepness of the Beverton-Holt stock-recruit relationship:
0.7, 0.8, 0.9, 1.0

List of models *considered* in the risk analysis

Model name	Number	Description
Env-Fix	1	Environment, Fixed
Env-Gro	2	Environment, Estimate growth
Env-Sel	3	Environment, Dome selectivity
Env-Mrt	4	Environment, Adult mortality
Rcr	5	Ricker
Ind	6	Index not representative
Srt-Fix	7	Short-term, Fixed
Srt-Gro	8	Short-term, Estimate growth
Srt-Sel	9	Short-term, Dome selectivity
Srt-Mrt	10	Short-term, Adult mortality
Mov	11	Pre-adult movement
Gro	12	Estimate growth
Sel	13	Dome selectivity
Mrt	14	Adult mortality
Cmp	15	Unrepresentative longline composition

List of models *retained* in the risk analysis

Model name	Number	Description	Note
Env-Fix	1	Environment, Fixed	
Env-Gro	2	Environment, Estimate growth	
Env-Sel	3	Environment, Dome selectivity	
Env-Mrt	4	Environment, Adult mortality	
~~Rcr~~		~~Ricker~~	**Not shown (model does not converge)**
~~Ind~~		~~Index not representative~~	**Not shown (model weight=0)**
Srt-Fix	5	Short-term, Fixed	
Srt-Gro	6	Short-term, Estimate growth	
Srt-Sel	7	Short-term, Dome selectivity	
Srt-Mrt	8	Short-term, Adult mortality	
Mov	9	Pre-adult movement	
Gro	11	Estimate growth	
Sel	11	Dome selectivity	
Mrt	12	Adult mortality	
~~Cmp~~		~~Unrepresentative longline composition~~	**Not shown (model weight=0)**

List of models *retained* in the risk analysis

Model name	Number	Description	h=0.7	h=0.8	h=0.9	h=1.0
Env-Fix	1	Environment, Fixed				
Env-Gro	2	Environment, Estimate growth				
Env-Sel	3	Environment, Dome selectivity				
Env-Mrt	4	Environment, Adult mortality				
Srt-Fix	5	Short-term, Fixed				
Srt-Gro	6	Short-term, Estimate growth		48 model runs		
Srt-Sel	7	Short-term, Dome selectivity				
Srt-Mrt	8	Short-term, Adult mortality				
Mov	9	Pre-adult movement				
Gro	11	Estimate growth				
Sel	11	Dome selectivity				
Mrt	12	Adult mortality				

Next step in the risk analysis approach

Described in Maunder et al. 2020 (SAC-11- INF-F):

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Thank you