Evaluation of post-season Chinook FRAM performance

Some date, 2021

To-do

- add stocks?
- add functionality for 2:1 ERA:FRAM stocks?
- add tab to show age-specific ERs?
- pull ERs from TAMMs for PS stocks?
- compare BYERs?
- figure out a better way to handle stocks with mat rates in more than one time step
- make mat-rate and AEQ figures taller?
- fill in text

Introduction

As part of the annual preseason planning process for setting salmon fisheries in the marine waters of Washington and Oregon, the Pacific Fishery Management Council (PFMC) and Washington co-managers use the Fishery Regulation Assessment Model (FRAM) to estimate impacts of proposed fisheries on various coho and Chinook stocks. For Chinook specifically, FRAM is used to help plan PFMC ocean fisheries that occur north of Cape Falcon, OR as well as those that occur in the Strait of Juan de Fuca and Puget Sound. The FRAM is a deterministic single-pool model where each model run occurs over a single year and estimates fishery impacts by stock for specific time periods and age classes. For details on model structure and computational processes, in addition to a user manual, see the FRAM Documentation Website.

The FRAM is rooted in a set of base period data derived through species-specific cohort analysis procedures that are based primarily on coded-wire tag (CWT) recoveries. Key Chinook base data include stock-age-fishery-time period specific exploitation rates, cohort sizes, maturation rates, adult equivalent (AEQ) rates, and growth function parameters. The original set of base period data for Chinook was derived from CWTs released during the 1974 - 1979 brood years and shared many of the same CWT tag groups that were used to represent exploitation rate indicator stocks and model stocks of the Pacific Salmon Commission (PSC) Chinook model that is used for fishery management in accordance with the Pacific Salmon Treaty (PST). In recent years, a considerable amount of effort has been devoted to contemporizing and continually refining the Chinook FRAM base period data set, which is now derived from CWTs released during the 2005 - 2008 brood years. The most current base period calibration, referred to as "Round 7.1" was created in June 2021 and was produced along with a time series of postseason model runs (referred to as validation runs) ranging from 1992 - 2018.

Utilizing these more contemporary base period years means that there is no longer overlap in the CWT tag groups used to represent many of the model stocks in both Chinook FRAM and the PSC Chinook model, as much of the base data for the PSC Chinook model are still rooted in earlier brood years. However, there is still considerable overlap between the tag codes used to represent many Chinook FRAM stocks and the brood year 2005 - 2008 tag codes used for exploitation rate indicator stocks as part of the Chinook Technical Committee's (CTC) annual Exploitation Rate Analysis (ERA). The purpose of this assessment is to provide an evaluation of FRAM postseason performance by comparing it with independently derived metrics from the CTC's annual ERA for appropriate stocks.

Similarities and differences between FRAM and ERA

- both rooted in standard CWT-based cohort analysis
- different IM rates (particularly in Puget Sound sport fisheries)
- ERA uses empirical recoveries throughout the time series, FRAM scales to base period
- given FRAM's reliance on a base period and the assumption of static parameters, it might be better to compare averages over time

Methods

Exploitation Rates

ERA

Each year the CTC conducts an "Exploitation Rate Analysis" (ERA), which involves a CWT-based cohort analysis that reconstructs the cohort size and exploitation rate history for a given set of exploitation rate indicator stocks. Results from this analysis, in addition to those from the annual PSC Chinokk Model calibration, are published in a two volume "Exploitation Rate Analysis and Model Calibration" report, where Volume One includes the body of the report and Volume Two includes associated appendices. Calendar year exploitation rates derived from the CTC's ERA can be obtained from AEQ total mortality distribution tables included in these appendices (see Appendix C in the above "Volume Two" link. Ocean exploitation rates for a given stock/year are calculated by summing the percentage distributions across all AABM and ISBM fisheries (terminal fisheries are excluded). It is important to note that, as the ERA is conducted using CWT tag codes with marked (adipose fin clipped) releases, these are estimates of exploitation rates experienced by the marked component of each stock. For stocks that are not subjected to significant mark-selective fisheries, the difference in exploitation rates between the unmarked (adipose intact) and marked components of the stock would be expected to me minimal. It is possible, however, that even in the absence of exposure to mark-selective fisheries, there could be differences in marked and unmarked exploitation rates on a stock due to differences in age composition between the two groups.

FRAM

Maturation Rates

ERA

FRAM

Unlike in the ERA, where maturation rates are calculated independently for each separate brood year, FRAM maturation rates are considered to be static and are an output of the base period calibration.

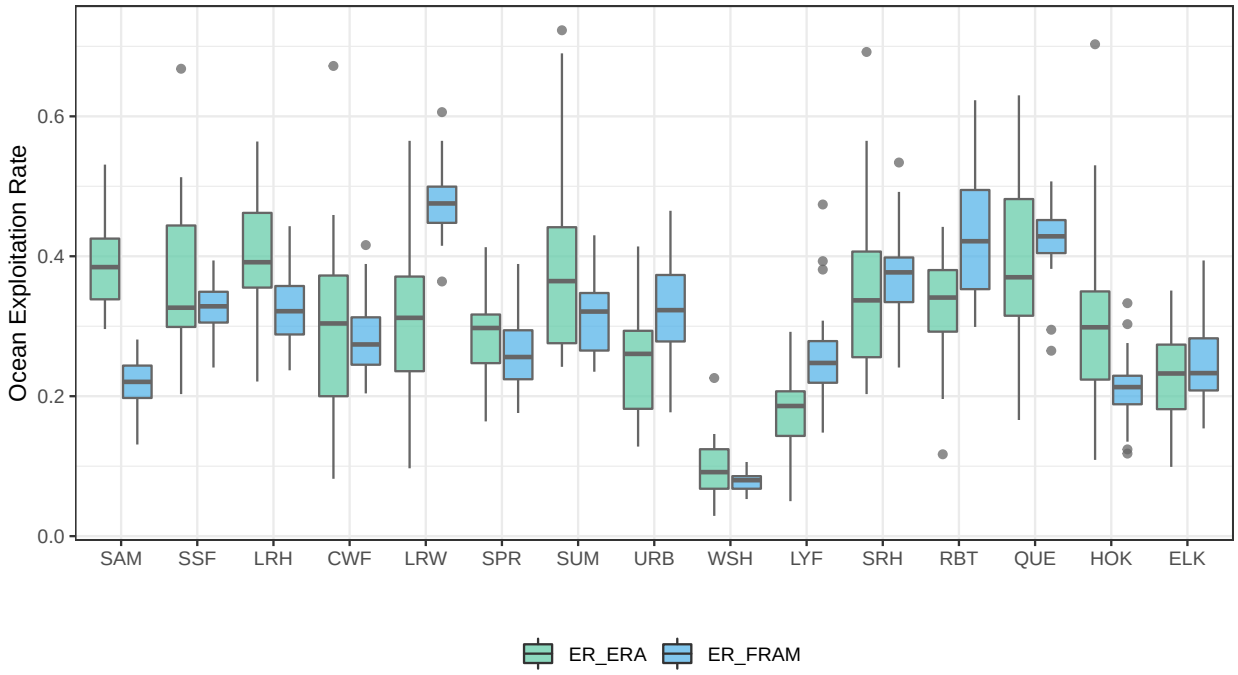
FRAM exploitation rates were based on postseason validation runs conducted in June 2021 and based on the latest version of the Chinook FRAM base period calibration, referred to as 'round 7.1'. For this analysis only preterminal (ocean) exploitation rates were evaluated, as FRAM does not account for terminal fishery impacts for many stocks. FRAM exploitation rates in a subset of fisheries , F, are calculated for a given stock, s, as:

$$ER_{s,F,cy} = \frac{\sum_{t=1}^{3}\left(\sum_{a=MinAge}^{MaxAge}\left(\sum_{f\in F} TotMort_{s,a,f,t} * AEQ_{s,a,t}\right)\right)}{\sum_{t=1}^{3}\left(\sum_{a=MinAge}^{MaxAge}\left(\sum_{f=1}^{NumFish} TotMort_{s,a,f,t} * AEQ_{s,a,t} + Esc_{s,a,t}\right)\right)}$$

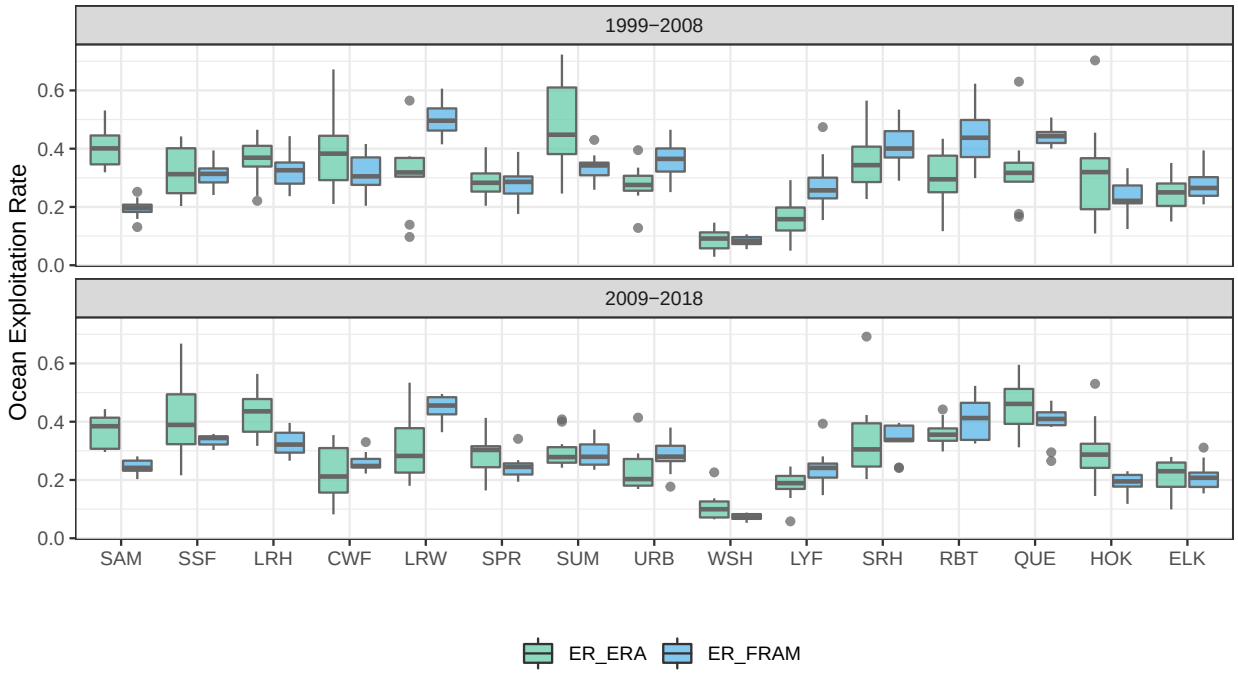
Results

Overall Summary Across Stocks

Entire Time Series



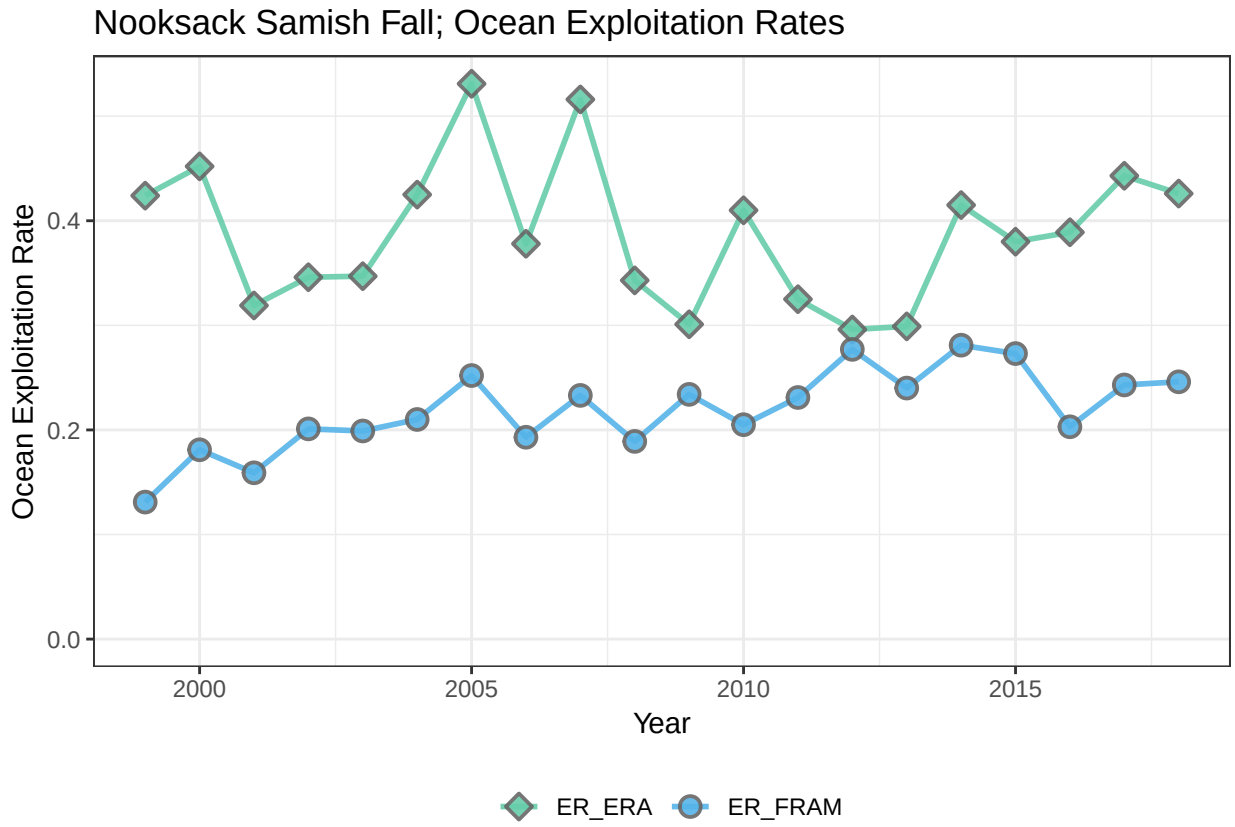
By Time Period

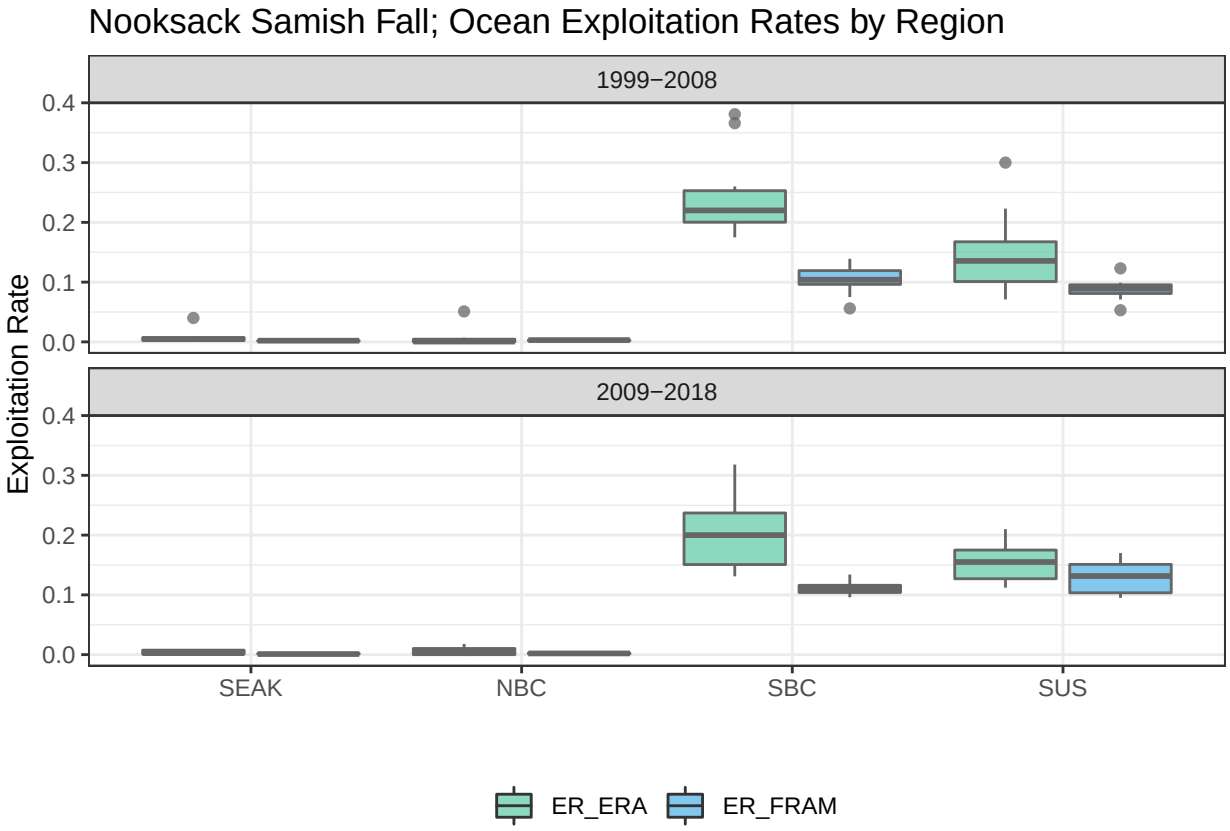


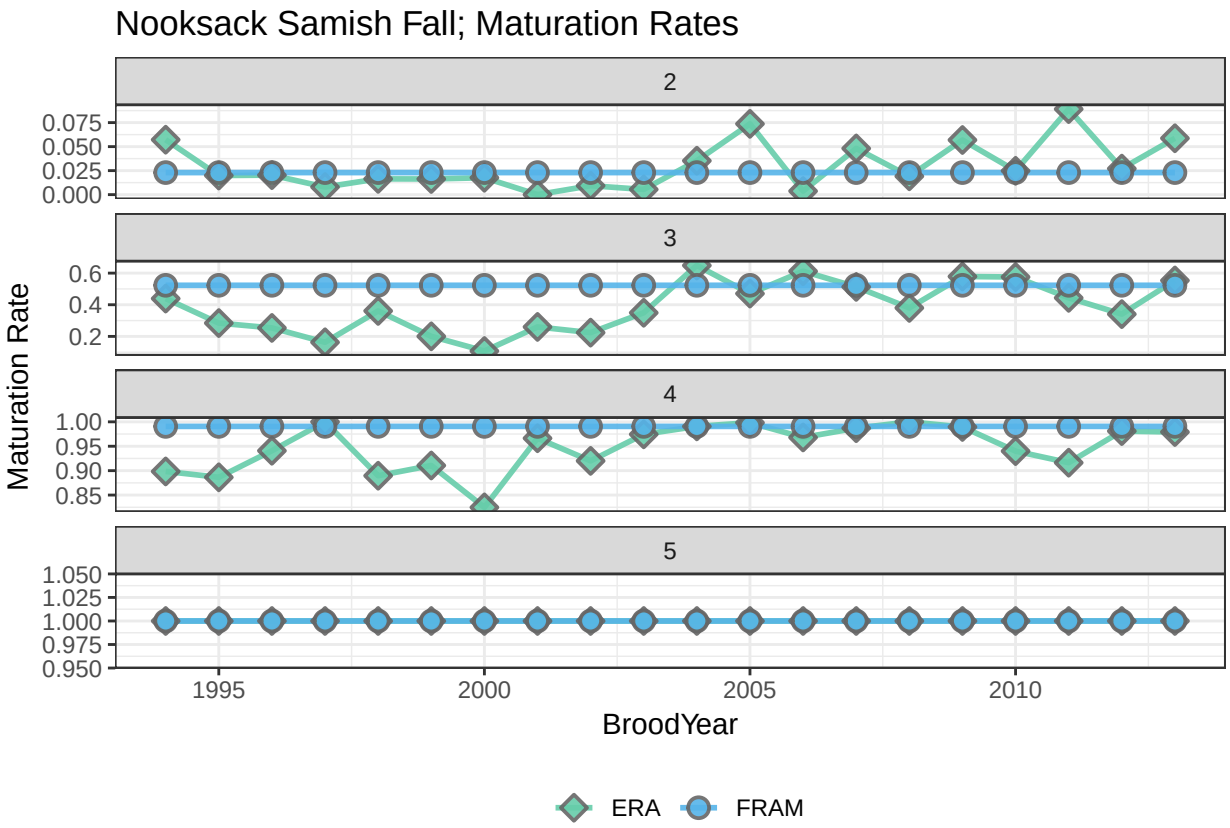
Stock	BroodYear	TagCode	ERA	FRAM
SAM	2005	633369	x	x
SAM	2005	633591		x
SAM	2006	633389	x	x
SAM	2006	634080		x
SAM	2007	634272	x	x
SAM	2007	634583		x
SAM	2008	634841	x	x
SAM	2008	635081		x

Individual Stock Results

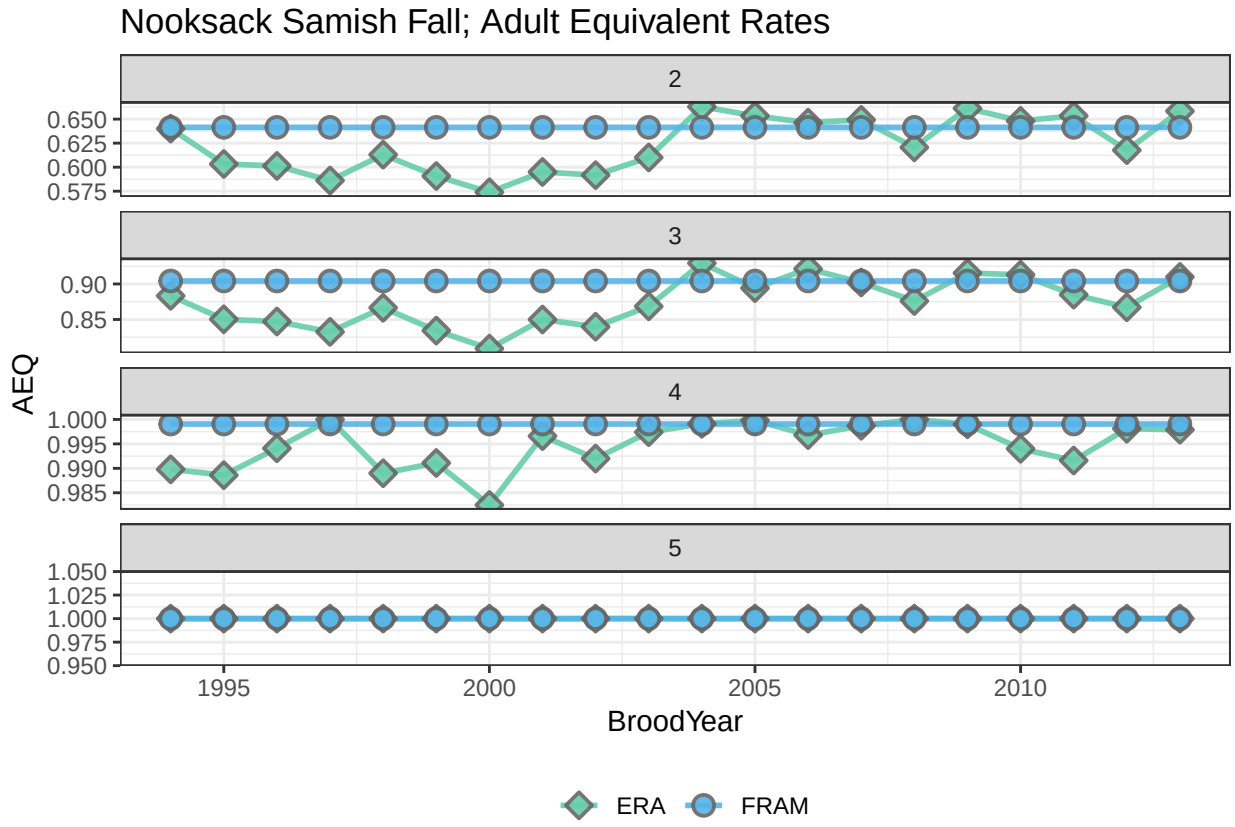
Nooksack Samish Fall



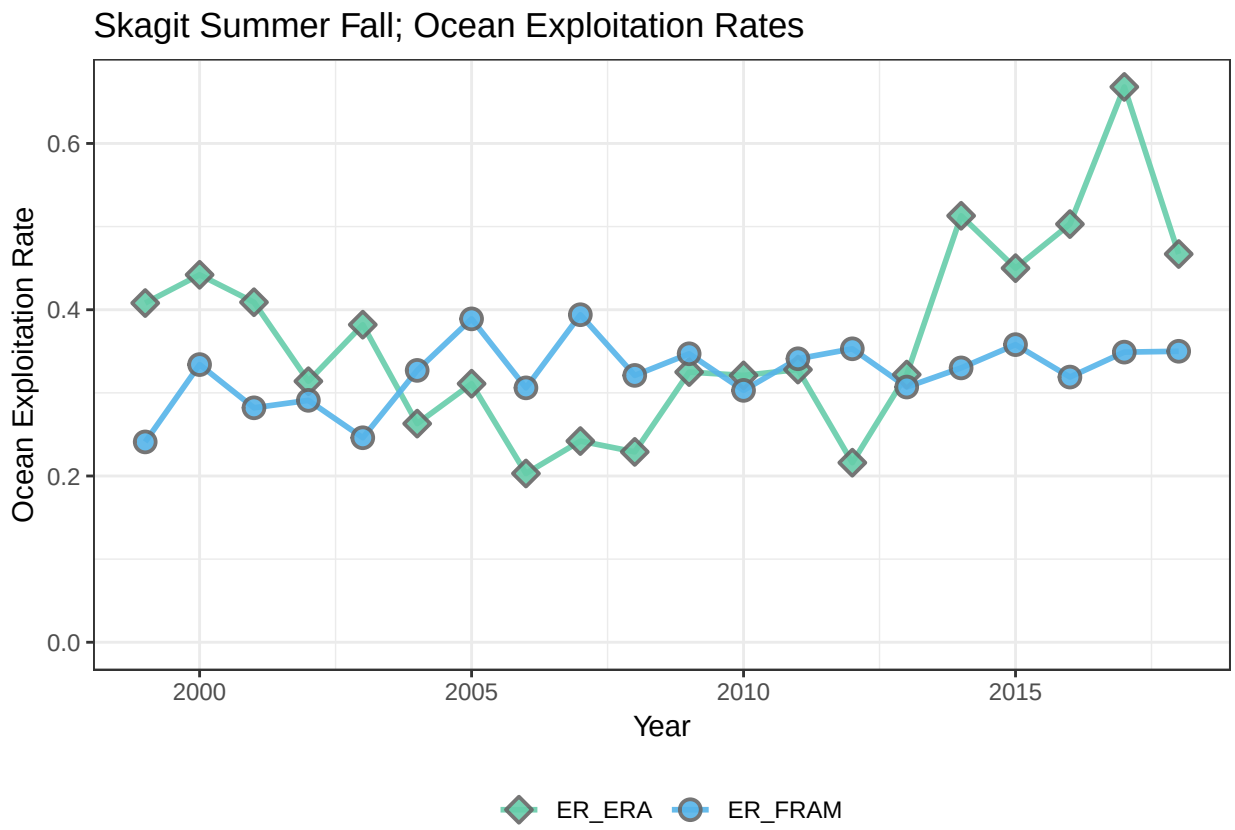

Nooksack Samish Fall; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
0.4
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

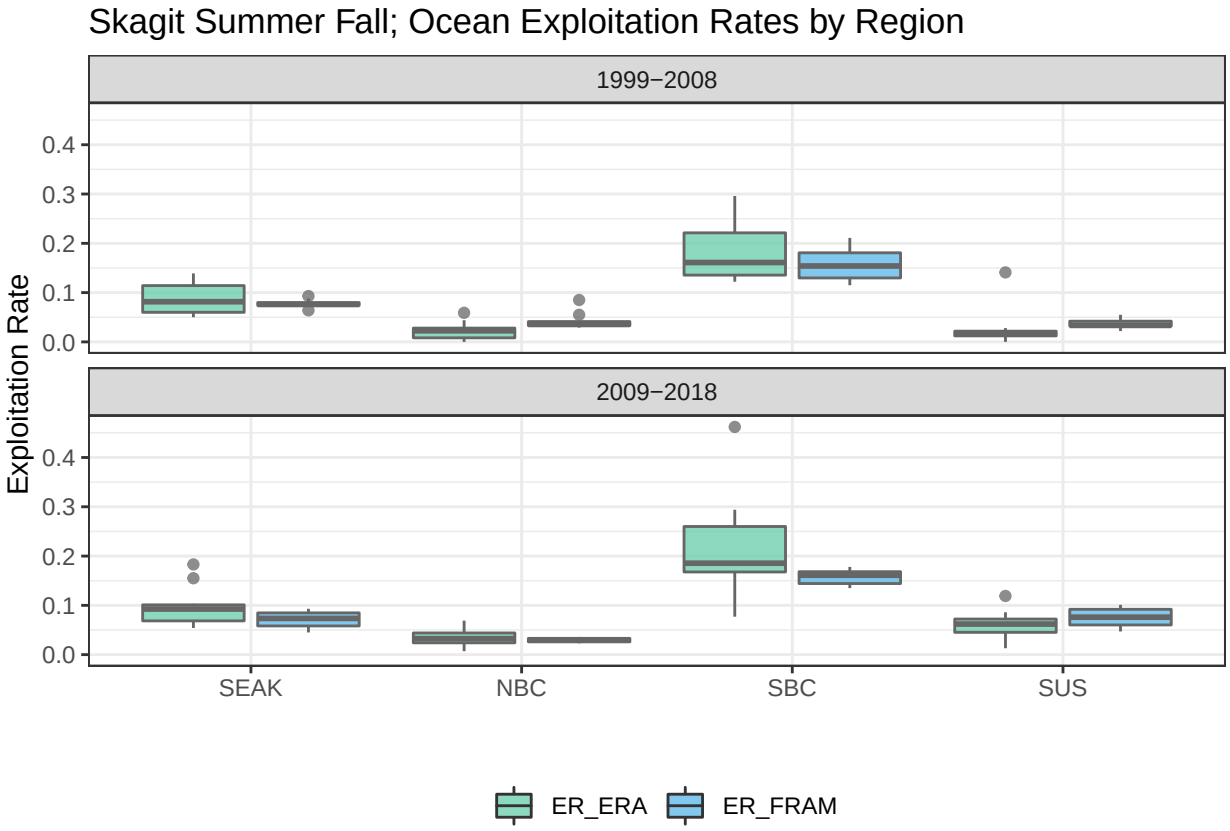

Nooksack Samish Fall; Maturation Rates
2
3
4
5
Maturation Rate
0.075
0.050
0.025
0.000
0.6
0.4
0.2
1.00
0.95
0.90
0.85
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

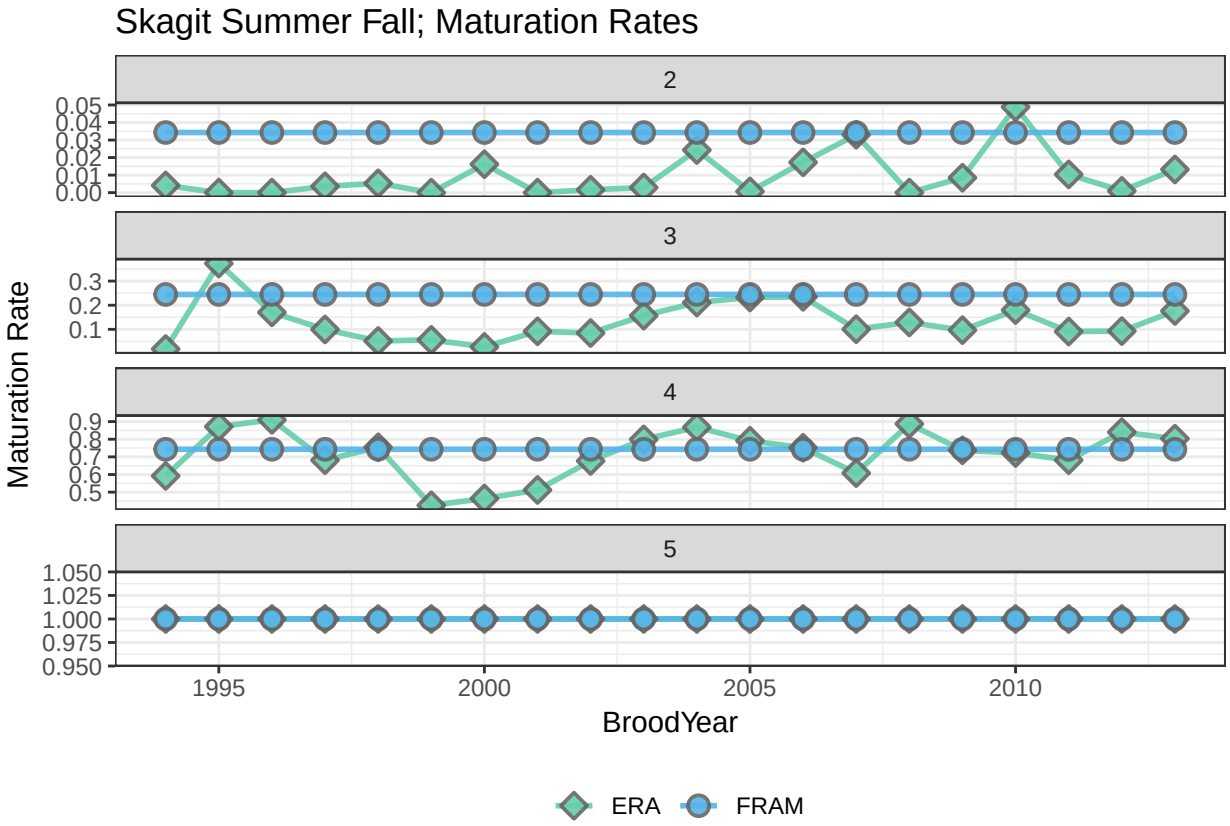
Stock	BroodYear	TagCode	ERA	FRAM
SSF	2005	210677	x	x
SSF	2005	212827	x	x
SSF	2005	210685		x
SSF	2006	210735	x	x
SSF	2006	210745		x
SSF	2007	210789	x	x
SSF	2007	210278		x
SSF	2008	210842	x	x
SSF	2008	210831		x



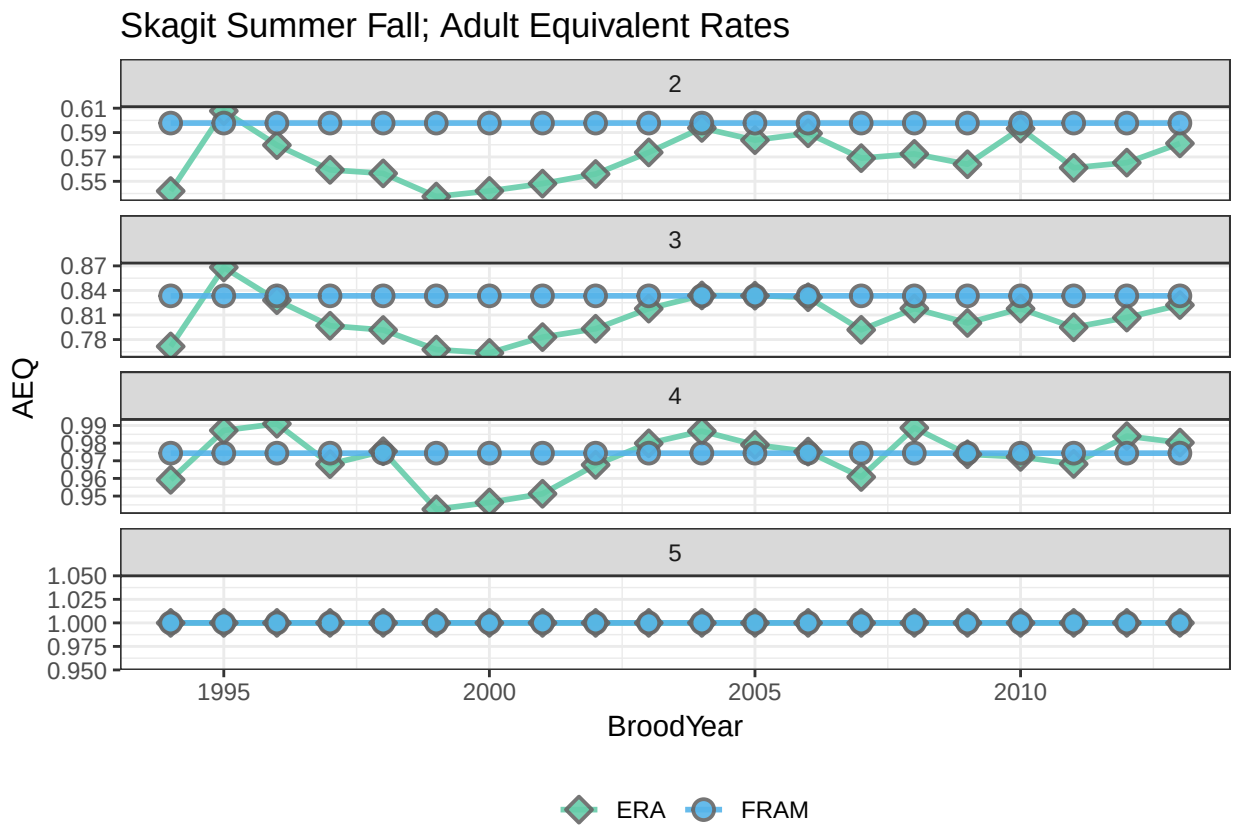
Skagit Summer Fall


Skagit Summer Fall; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.2
0.4
0.6
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

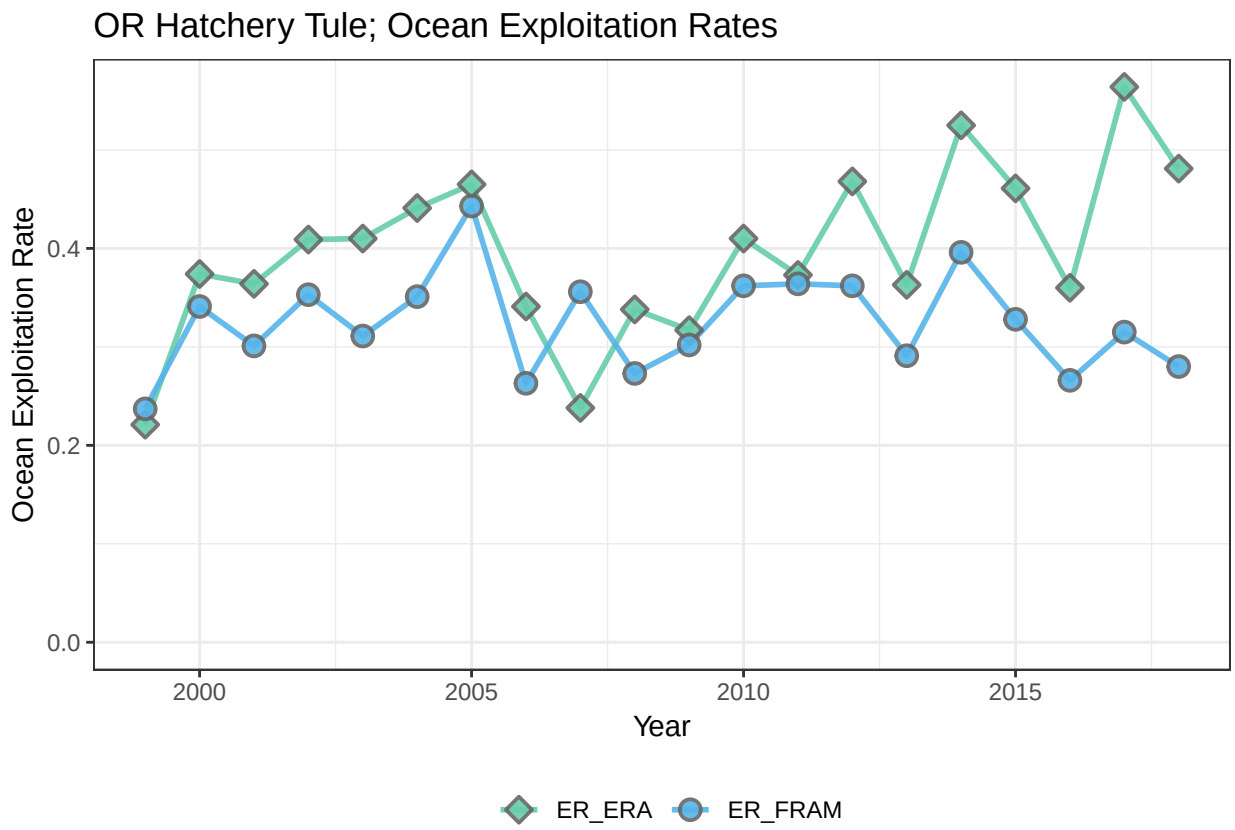

Skagit Summer Fall; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
0.4
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

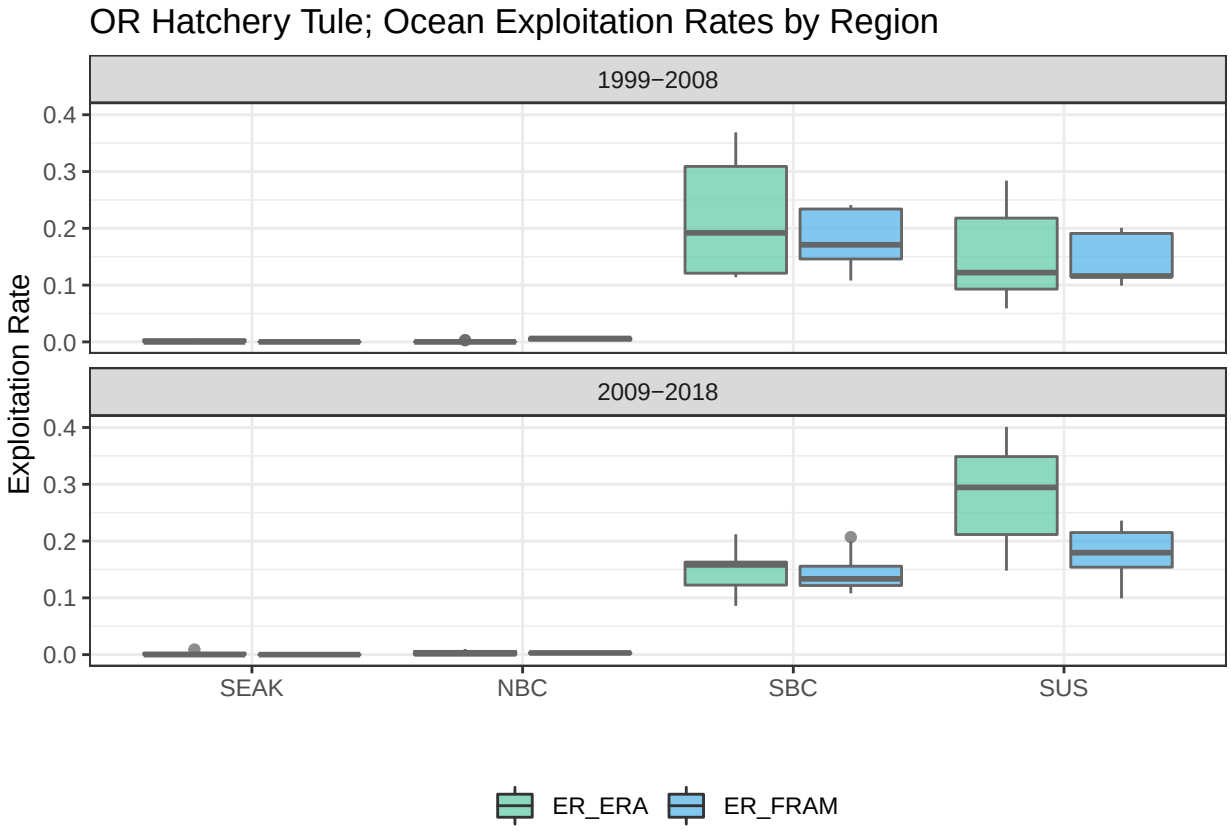

Skagit Summer Fall; Maturation Rates
2
3
4
5
Maturation Rate
0.05
0.04
0.03
0.02
0.01
0.00
0.3
0.2
0.1
0.9
0.8
0.7
0.6
0.5
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

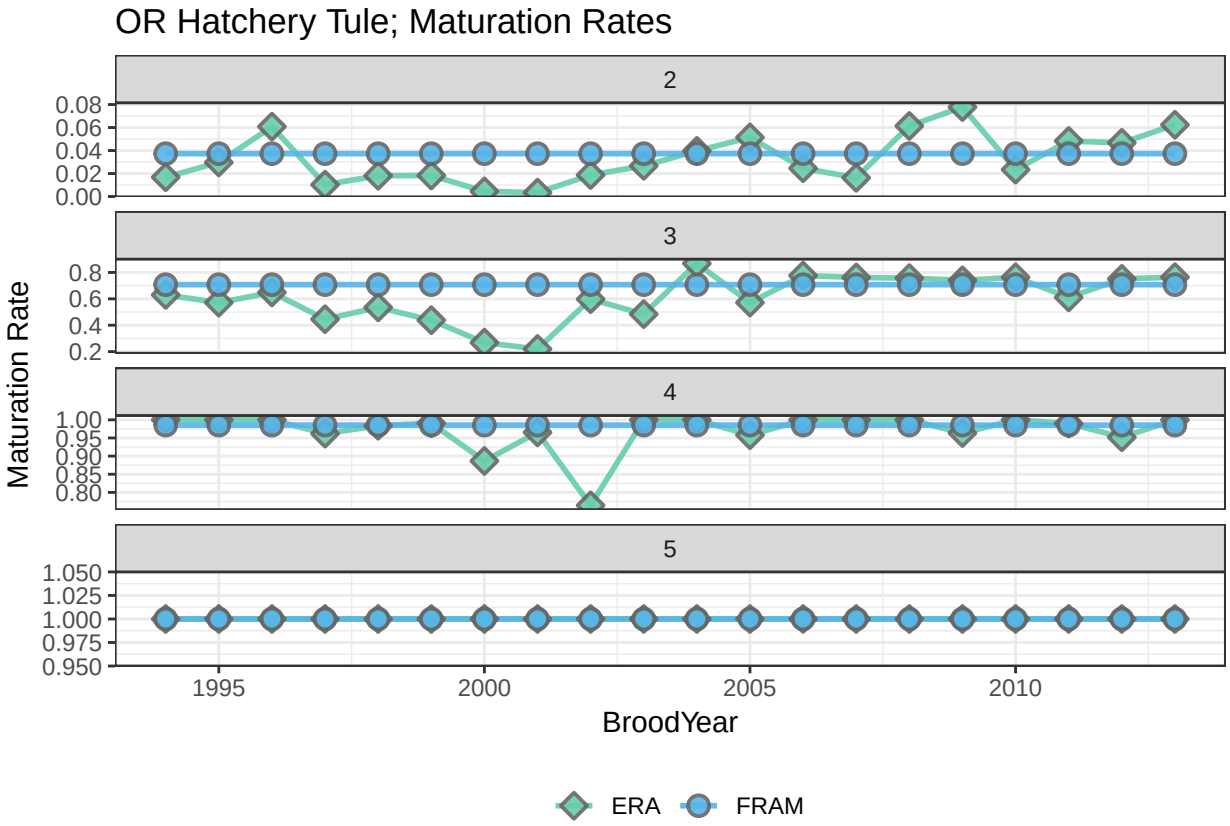
Stock	BroodYear	TagCode	ERA	FRAM
LRH	2005	094423	x	x
LRH	2006	094526	x	x
LRH	2007	094646	x	x
LRH	2008	090199	x	x



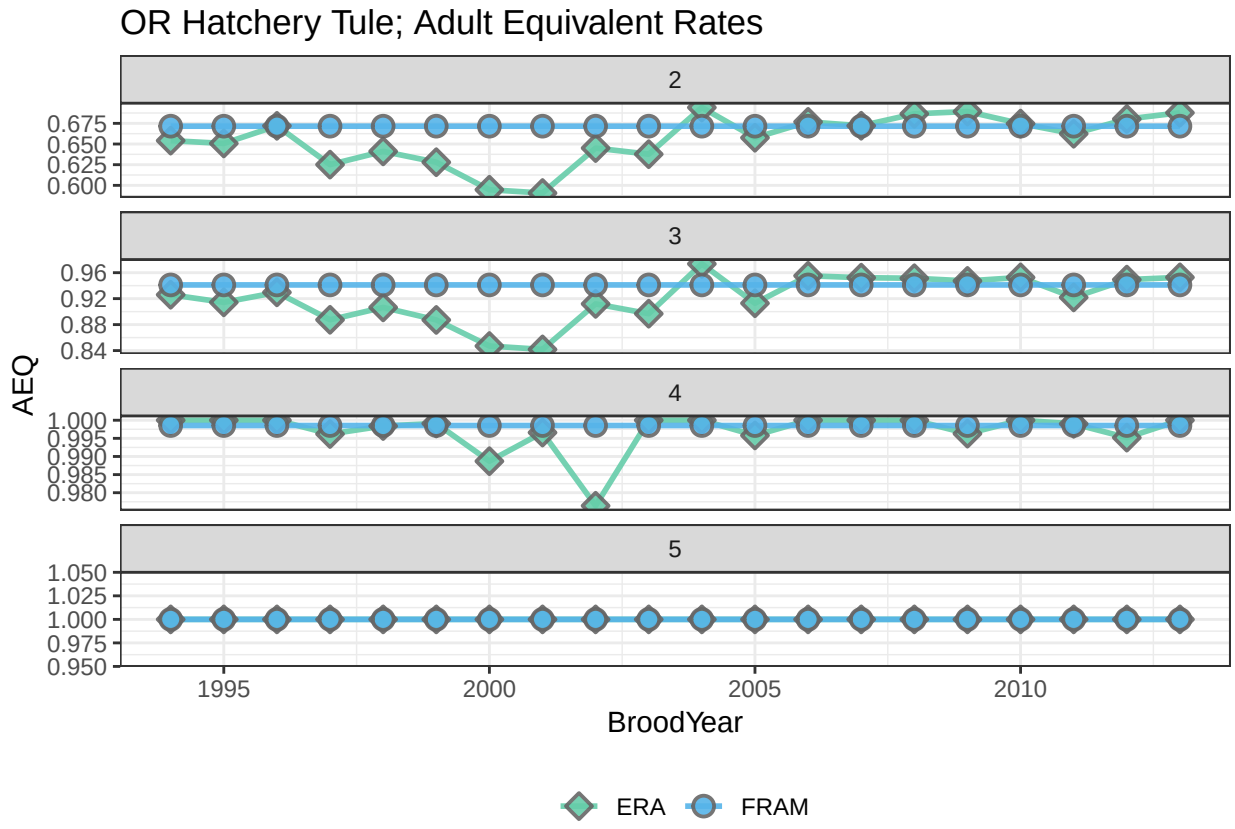
OR Hatchery Tule


OR Hatchery Tule; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.2
0.4
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

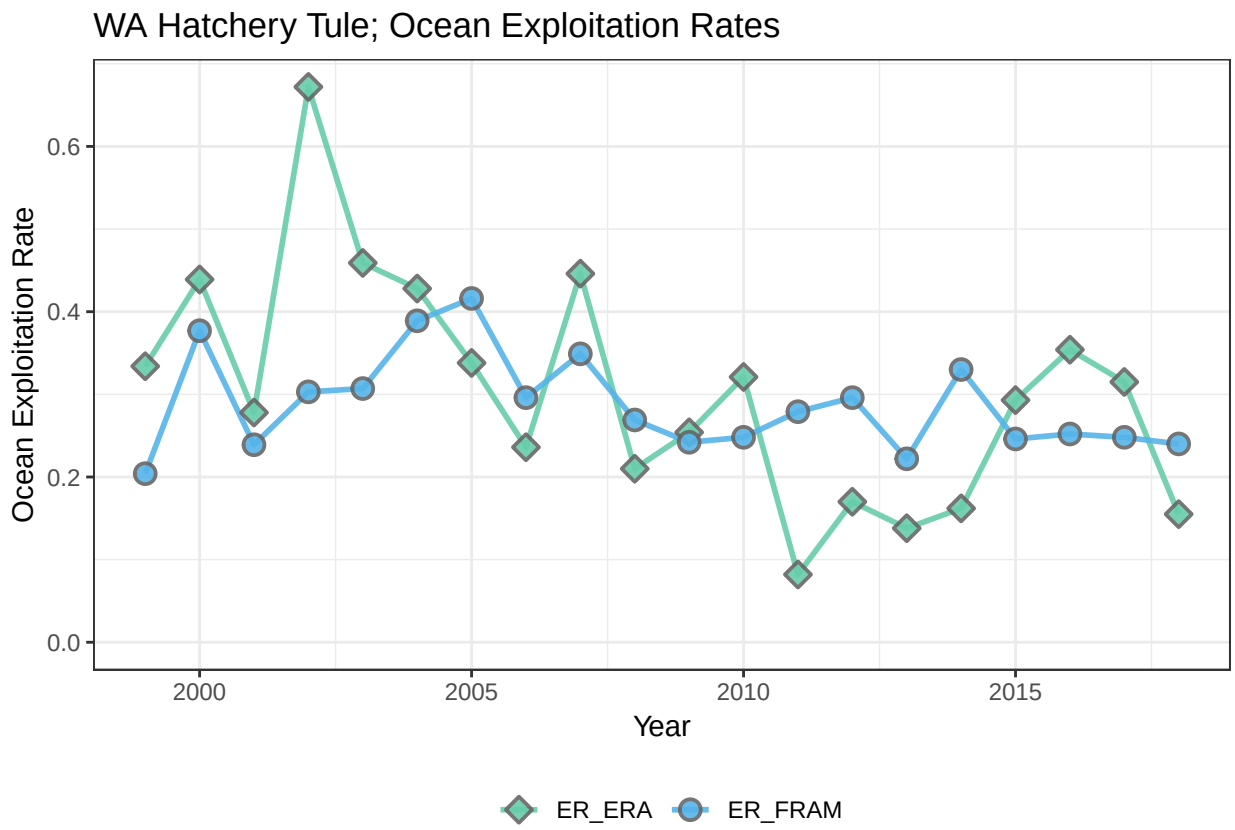

OR Hatchery Tule; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
0.4
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

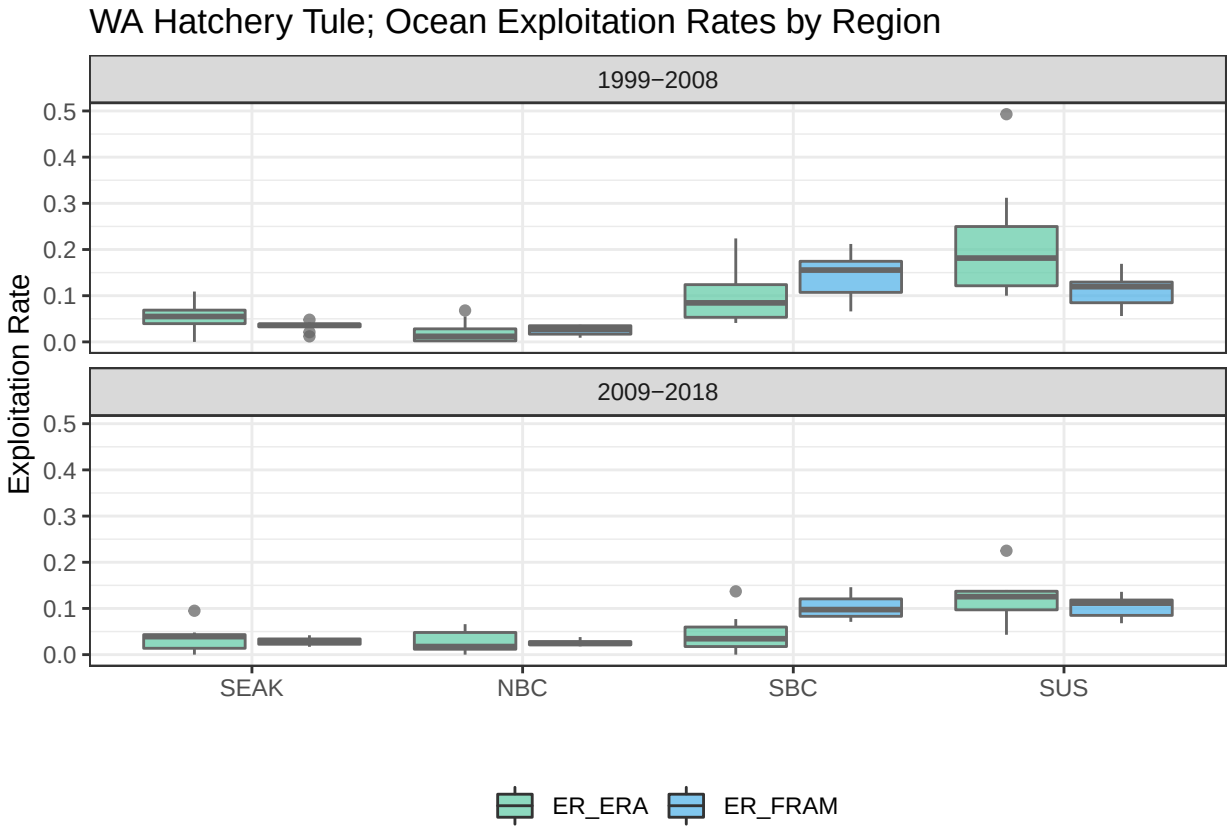

OR Hatchery Tule; Maturation Rates
2
3
4
5
Maturation Rate
0.08
0.06
0.04
0.02
0.00
0.8
0.6
0.4
0.2
1.00
0.95
0.90
0.85
0.80
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

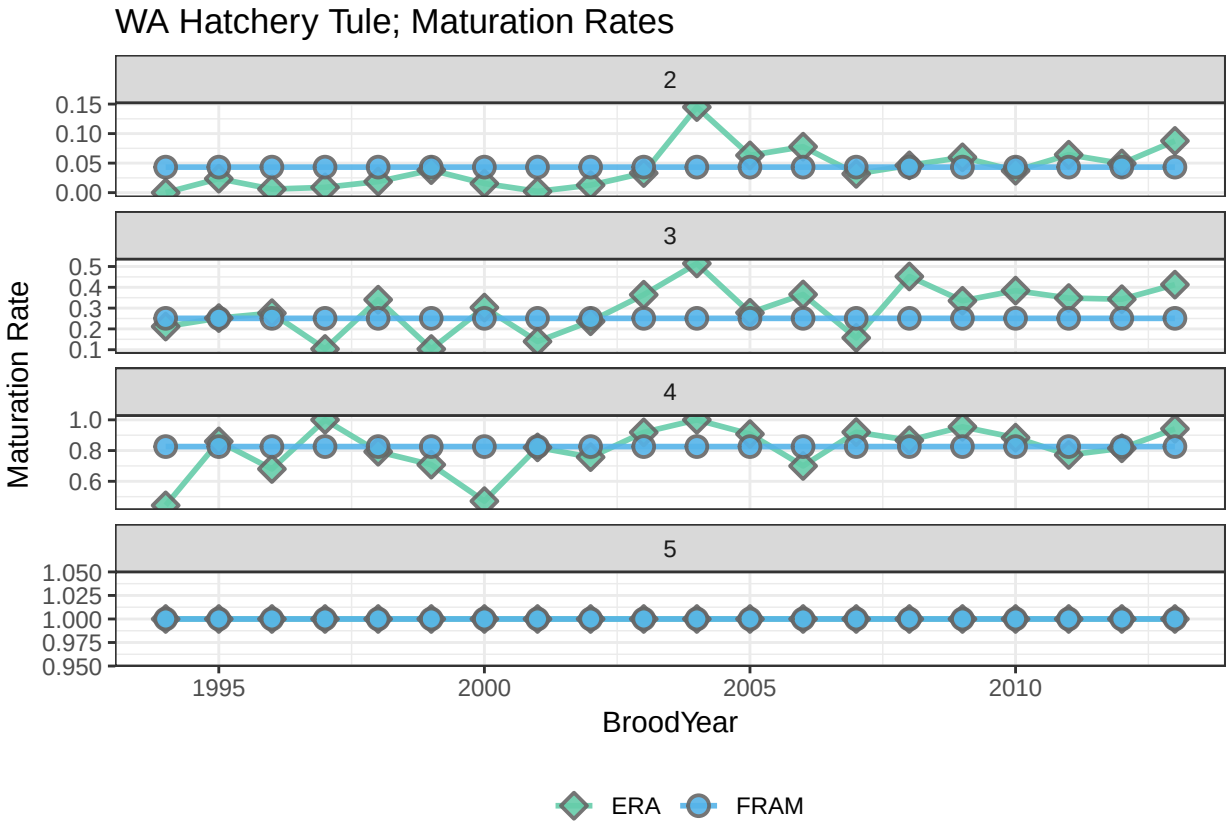
Stock	BroodYear	TagCode	ERA	FRAM
CWF	2005	633287	x	x
CWF	2005	632886		x
CWF	2005	632883		x
CWF	2006	633877	x	x
CWF	2006	633977		x
CWF	2006	633976		x
CWF	2007	634280	x	x
CWF	2007	634372		x
CWF	2007	634369		x
CWF	2008	634279	x	x
CWF	2008	634774		x
CWF	2008	634385		x
CWF	2008	634775		x



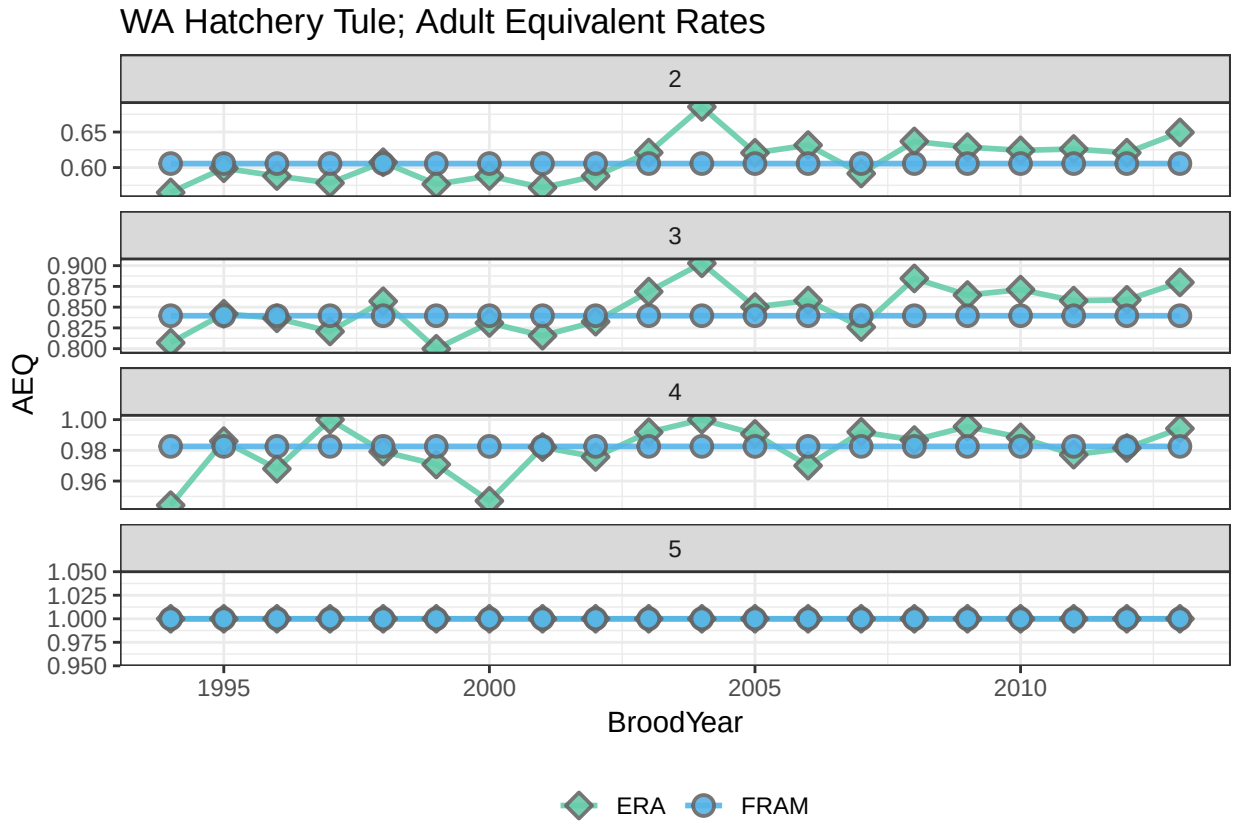
WA Hatchery Tule


WA Hatchery Tule; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.2
0.4
0.6
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

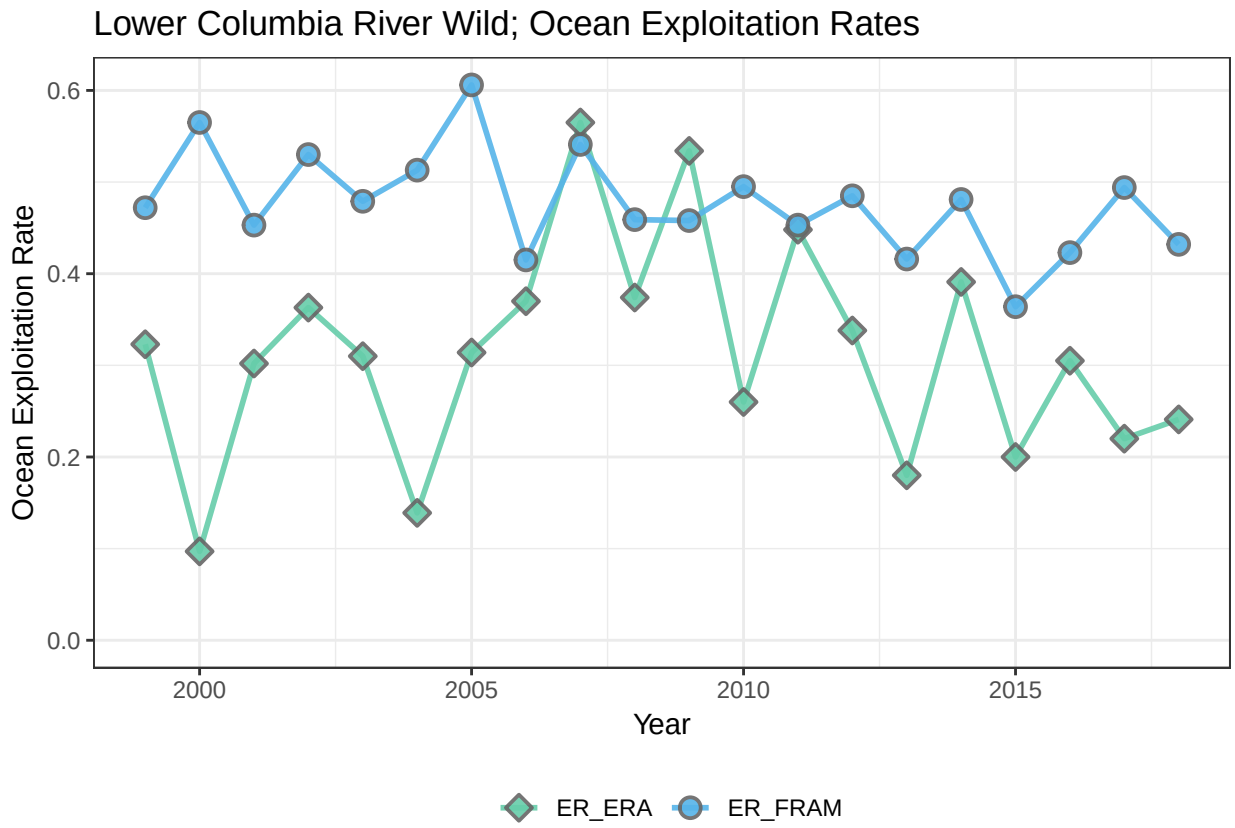

WA Hatchery Tule; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
0.4
0.5
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

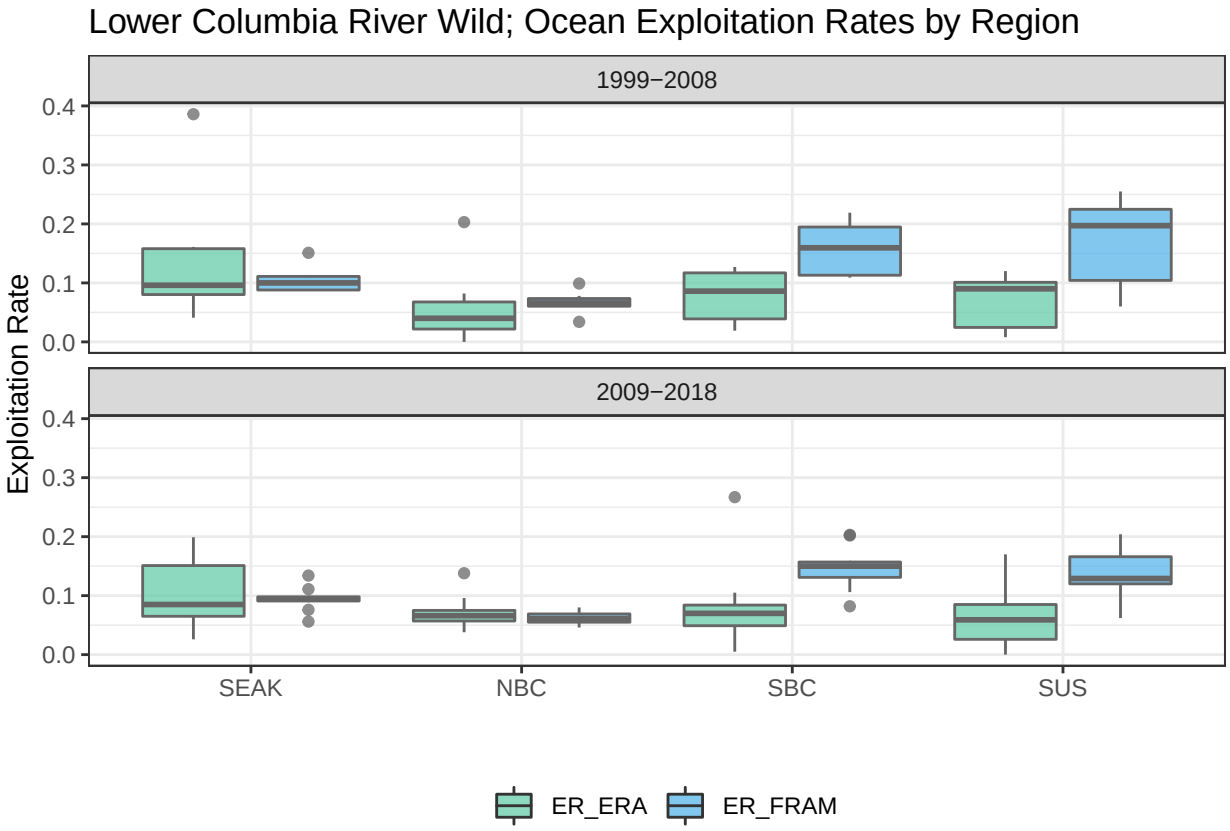

WA Hatchery Tule; Maturation Rates
2
3
4
5
Maturation Rate
0.15
0.10
0.05
0.00
0.5
0.4
0.3
0.2
0.1
1.0
0.8
0.6
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

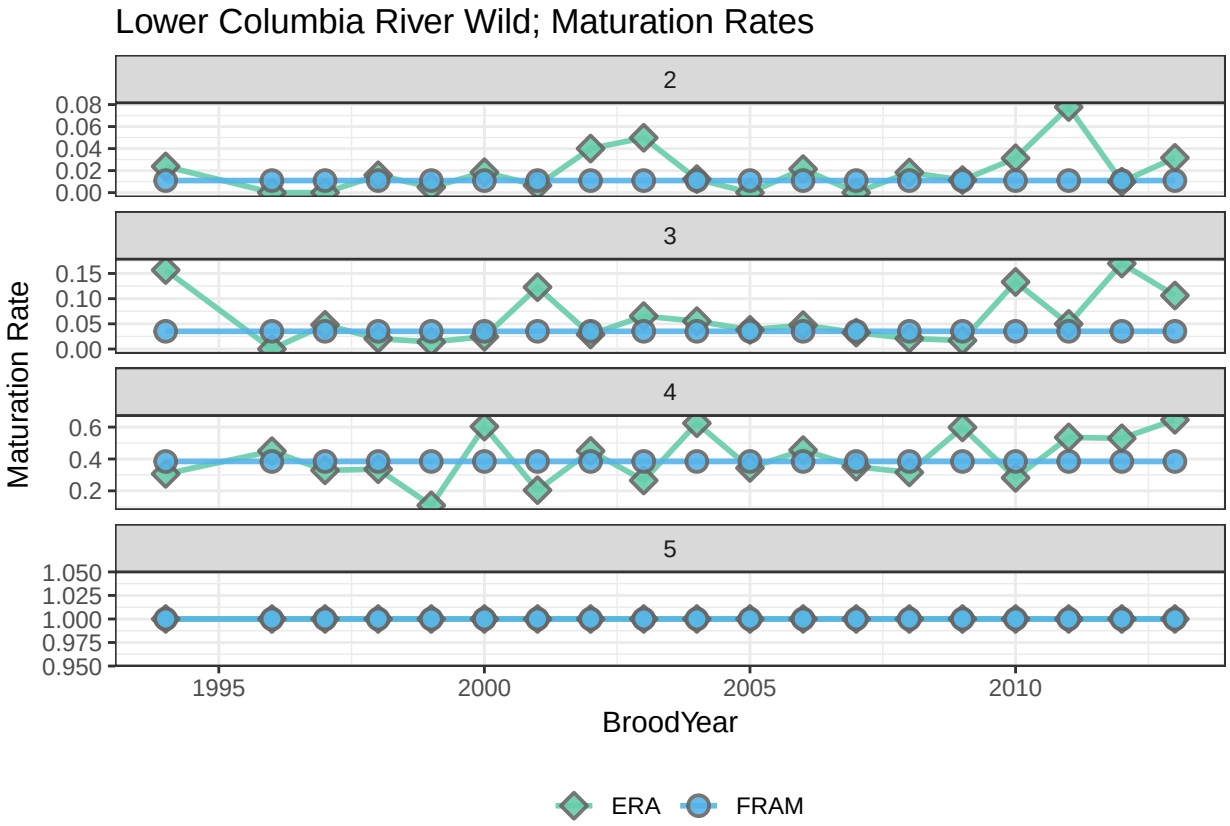
Stock	BroodYear	TagCode	ERA	FRAM
LRW	2005	632986	x	
LRW	2005	632987	x	x
LRW	2006	633492	x	x
LRW	2006	633979	x	x
LRW	2007	634186	x	x
LRW	2008	634382	x	x

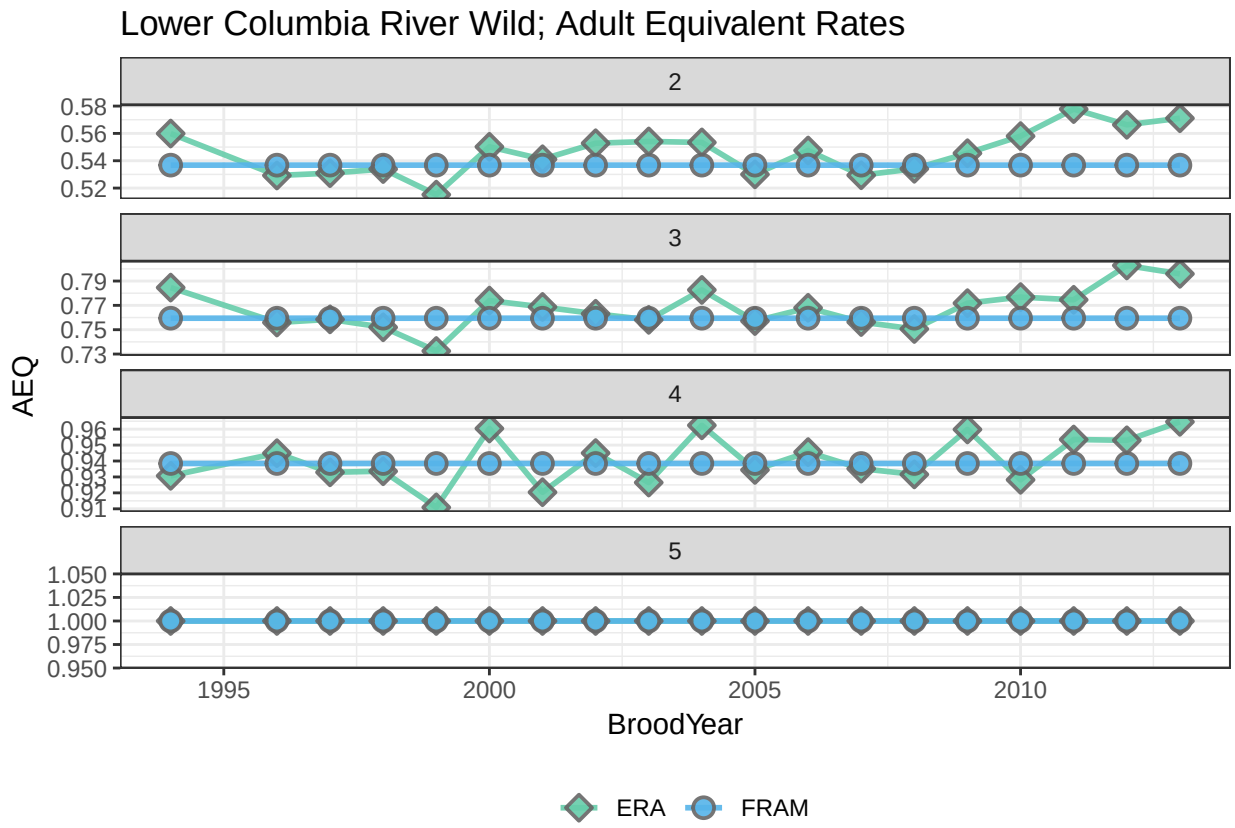


Lower Columbia River Wild


Lower Columbia River Wild; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.2
0.4
0.6
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

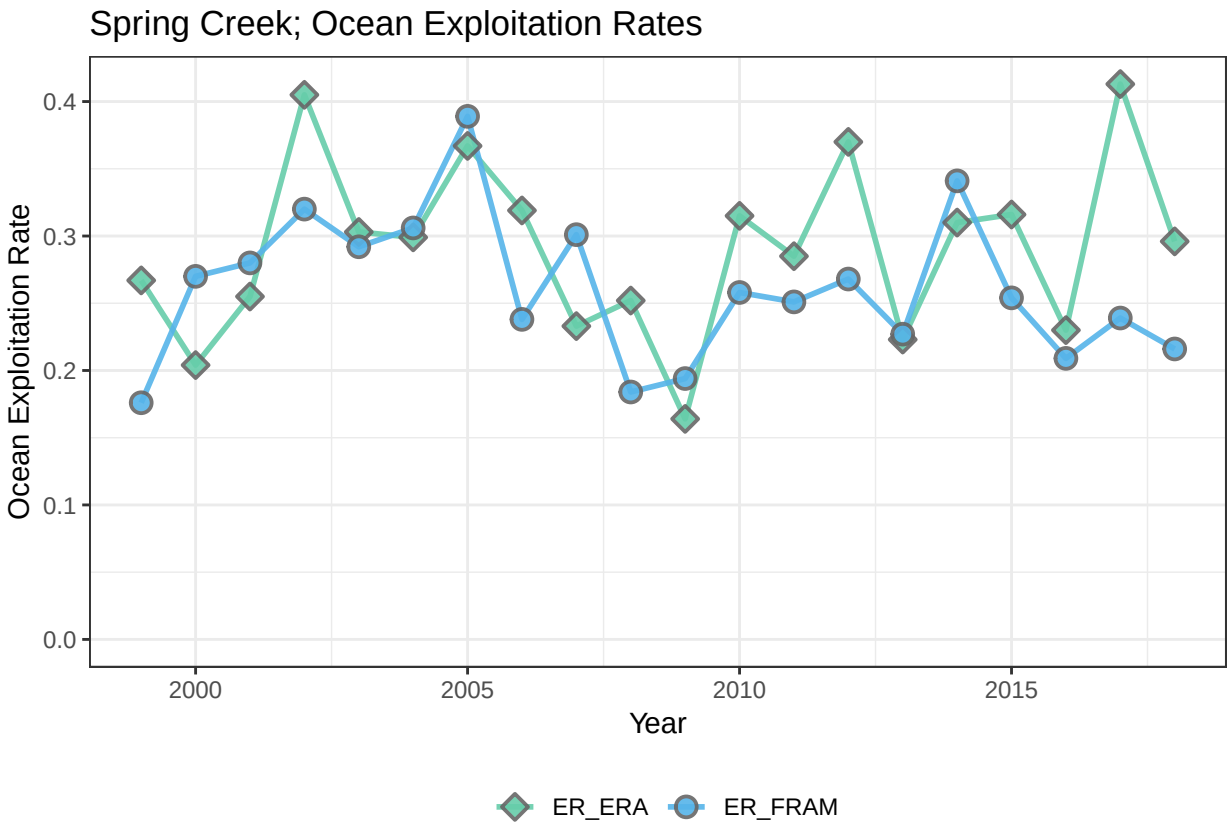

Lower Columbia River Wild; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
0.4
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

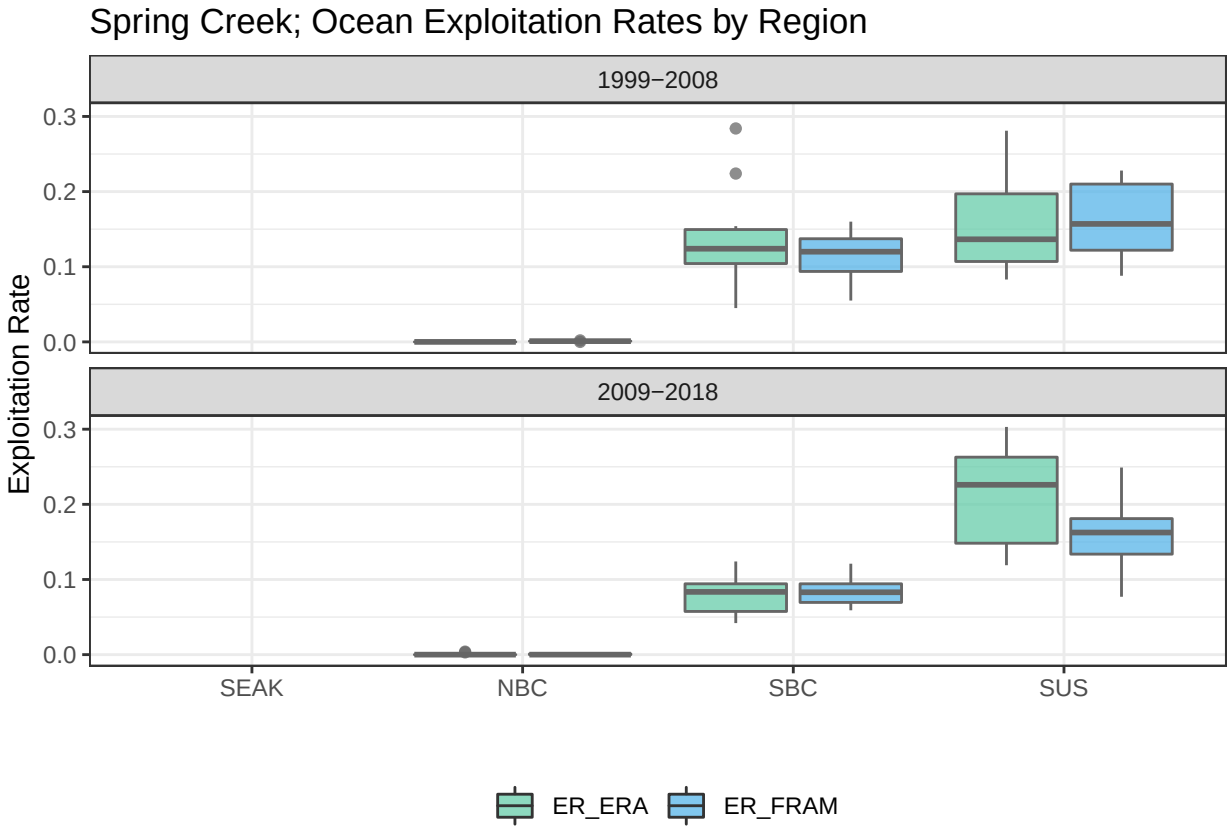

Lower Columbia River Wild; Maturation Rates
2
3
4
5
Maturation Rate
0.08
0.06
0.04
0.02
0.00
0.15
0.10
0.05
0.00
0.6
0.4
0.2
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

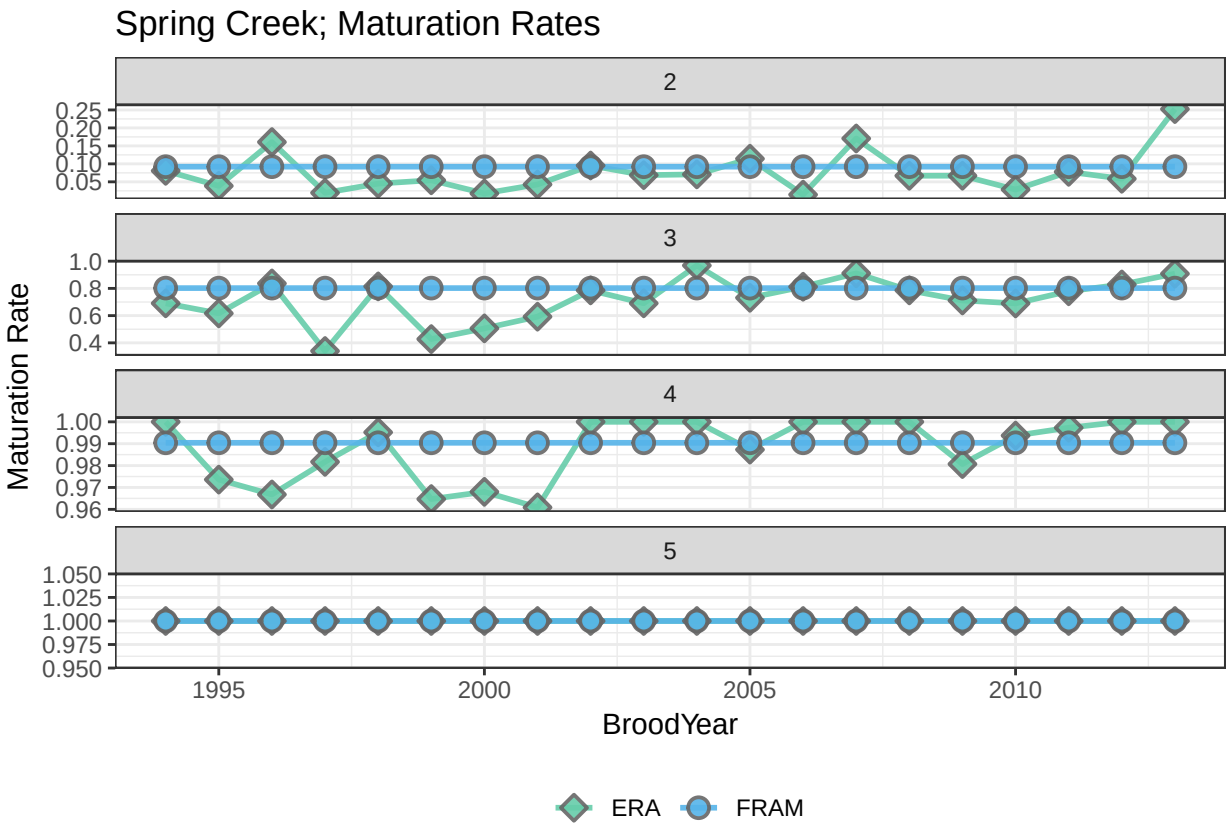


Spring Creek

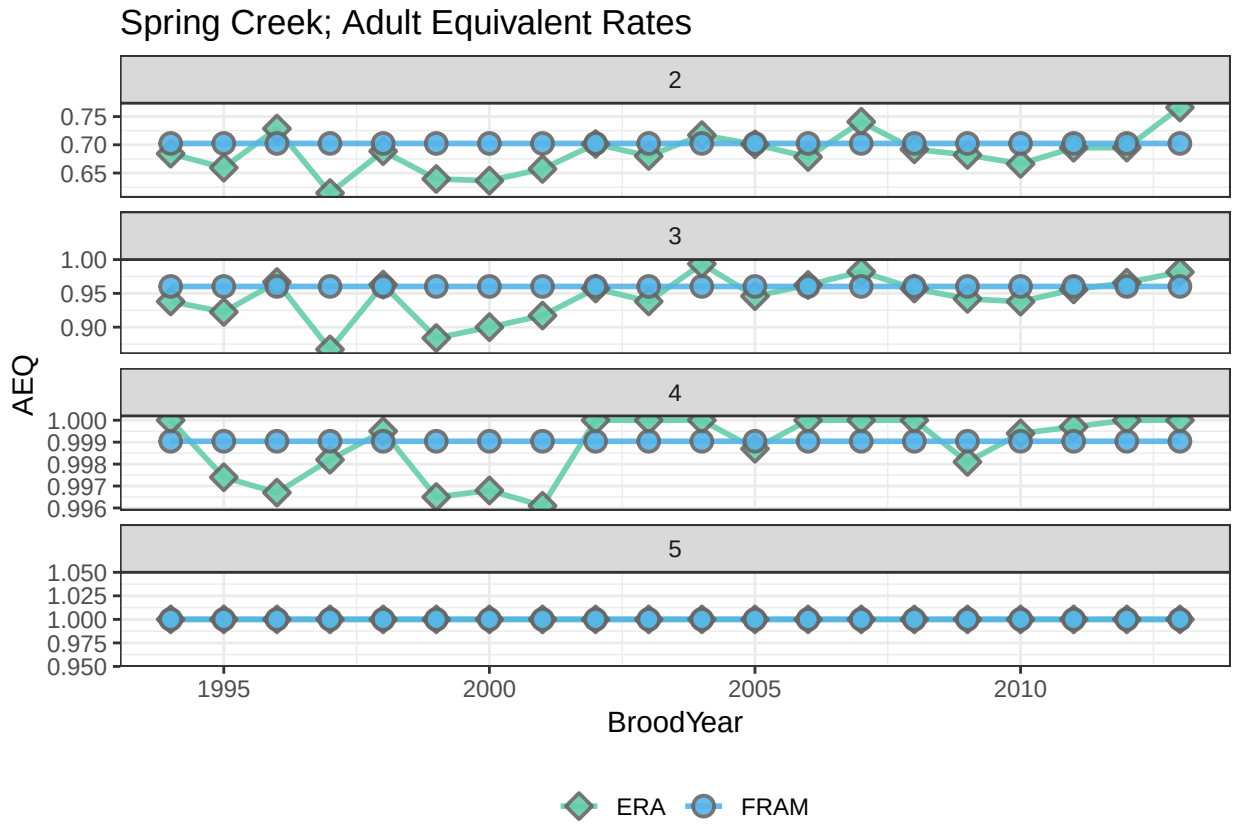
Stock	BroodYear	TagCode	ERA	FRAM
SPR	2005	052873	x	x
SPR	2005	052874	x	x
SPR	2005	052971	x	x
SPR	2005	052972	x	x
SPR	2006	052570	x	x
SPR	2006	052577	x	x
SPR	2006	052588	x	x
SPR	2006	052895	x	x
SPR	2006	052897	x	x
SPR	2006	053592	x	x
SPR	2006	054318	x	x
SPR	2006	054336	x	x
SPR	2007	050685	x	x
SPR	2007	052978	x	x
SPR	2007	053767	x	x
SPR	2007	053776	x	x
SPR	2007	053778	x	x
SPR	2007	053780	x	x
SPR	2007	053782	x	x
SPR	2007	053874	x	x
SPR	2007	054274	x	x
SPR	2007	054276	x	x
SPR	2008	054864	x	x
SPR	2008	054866	x	x



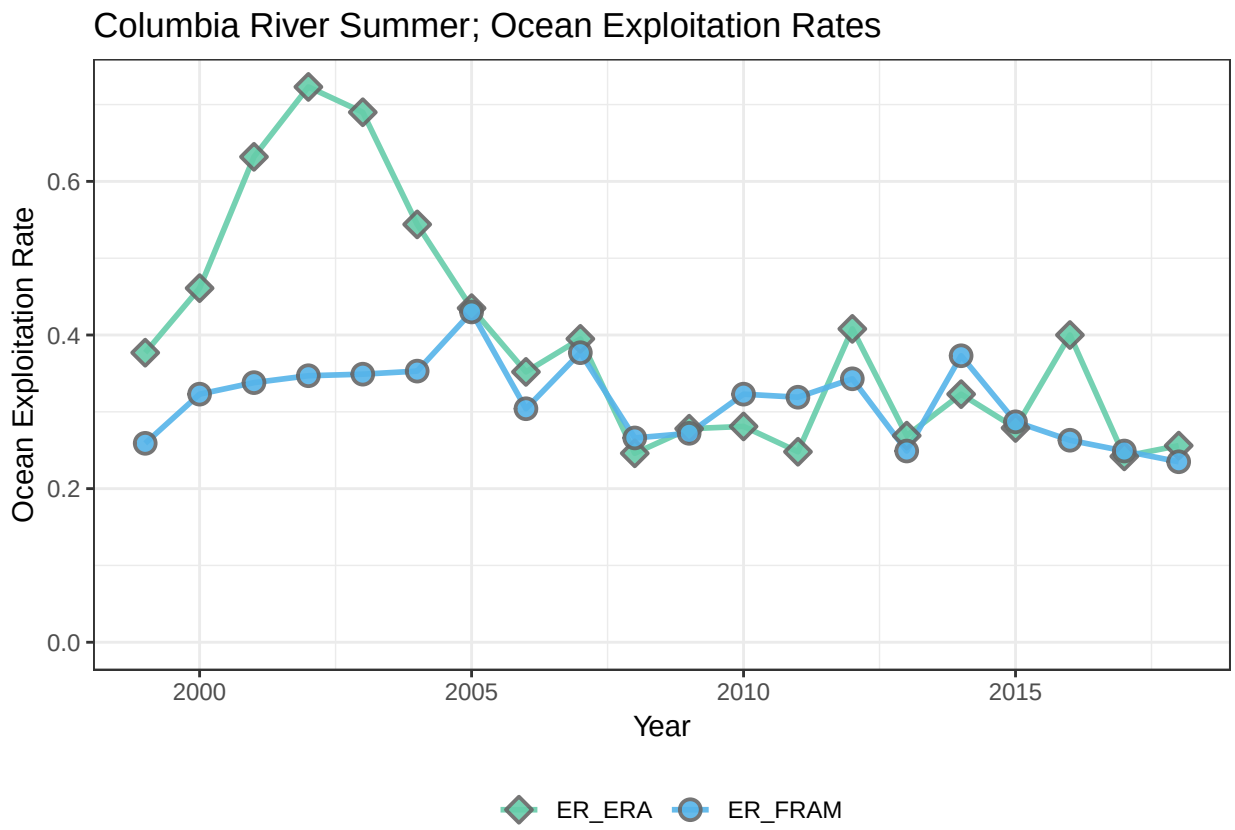

Spring Creek; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

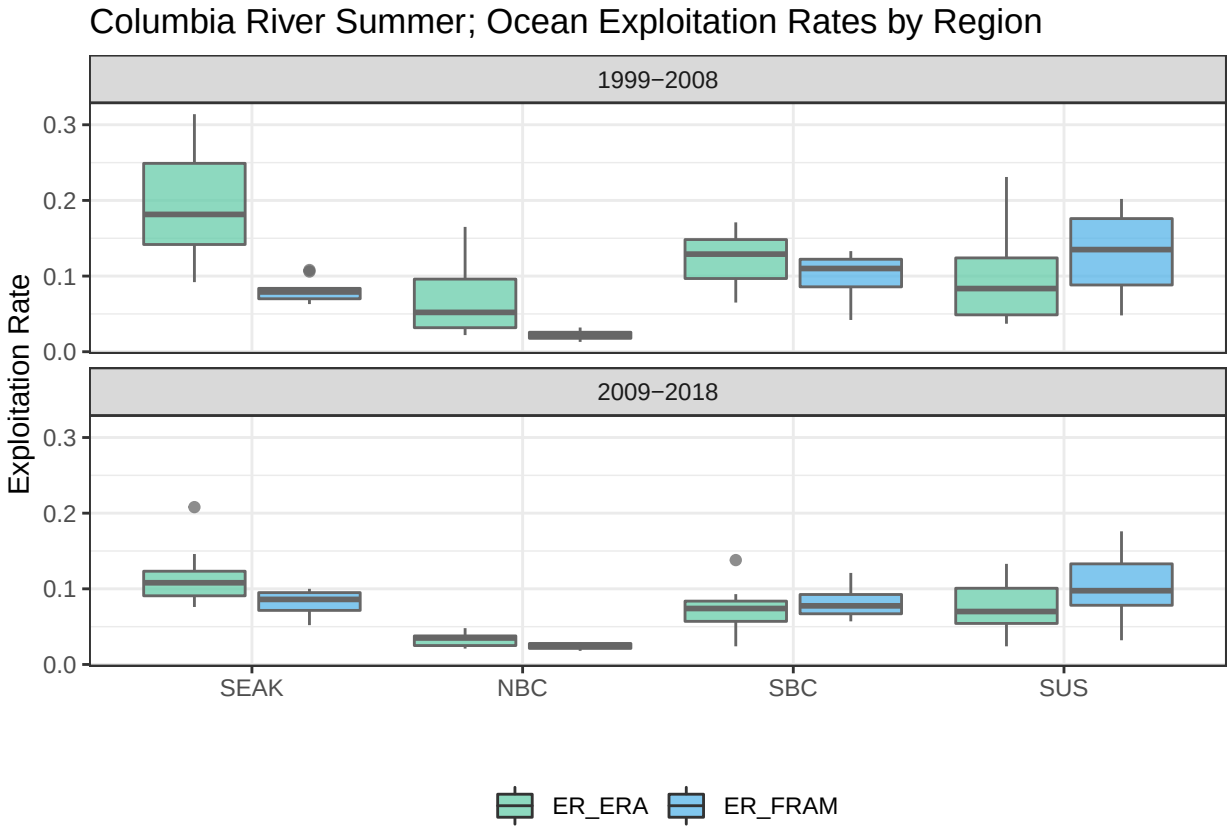

Spring Creek; Maturation Rates
2
3
4
5
Maturation Rate
0.25
0.20
0.15
0.10
0.05
1.0
0.8
0.6
0.4
1.00
0.99
0.98
0.97
0.96
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

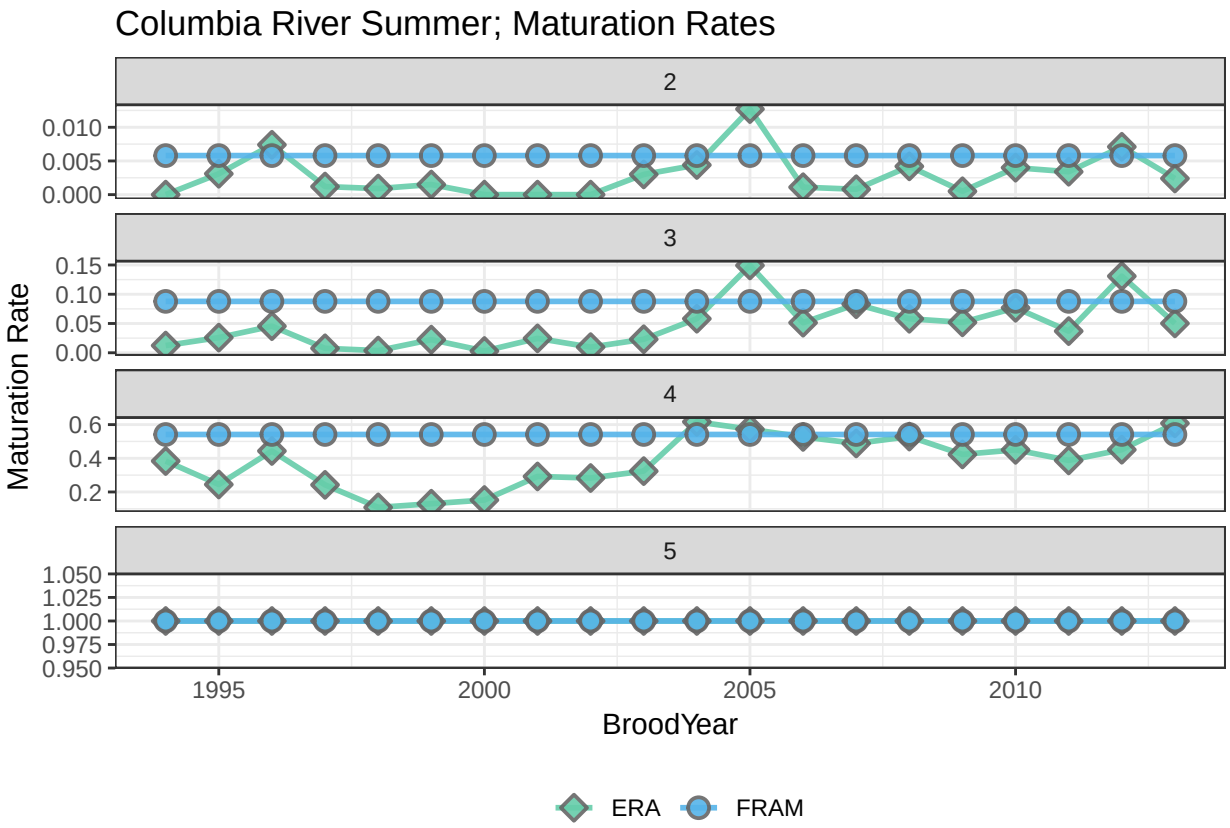
Stock	BroodYear	TagCode	ERA	FRAM
SUM	2005	633298	x	x
SUM	2005	633299	x	x
SUM	2005	633596	x	x
SUM	2006	633385	x	x
SUM	2006	633386	x	x
SUM	2006	633799	x	x
SUM	2007	633871	x	x
SUM	2007	633872	x	x
SUM	2007	634287	x	x
SUM	2007	634390	x	x
SUM	2008	634876	x	x
SUM	2008	635092	x	x
SUM	2008	635093	x	x



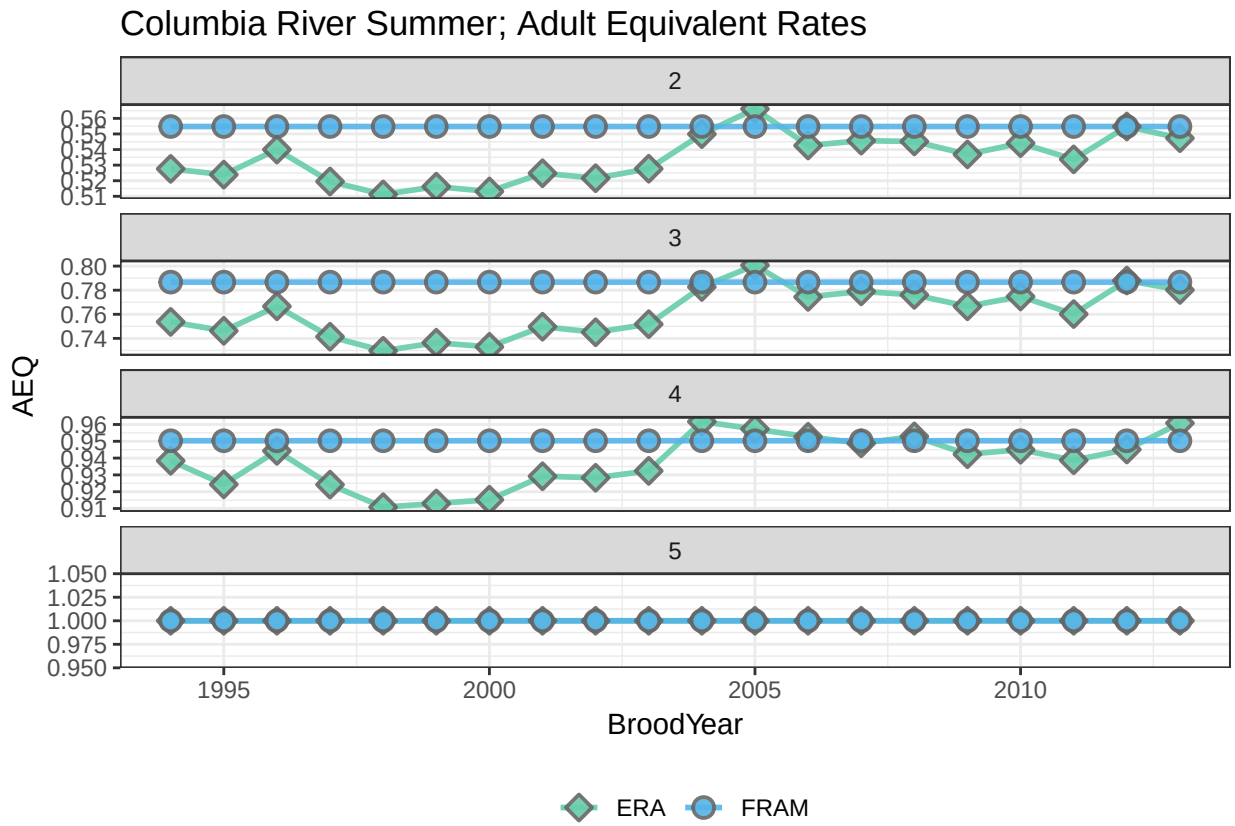
Columbia River Summer


Columbia River Summer; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.2
0.4
0.6
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

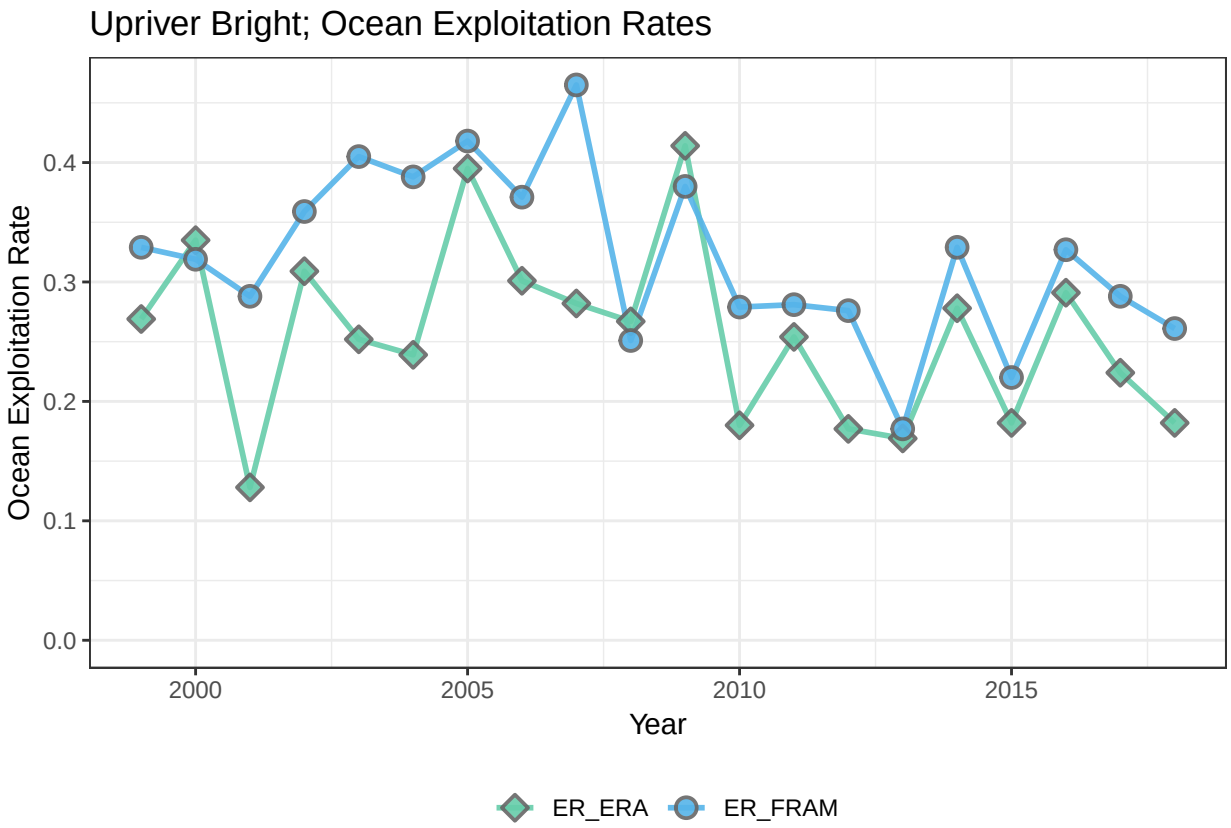

Columbia River Summer; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

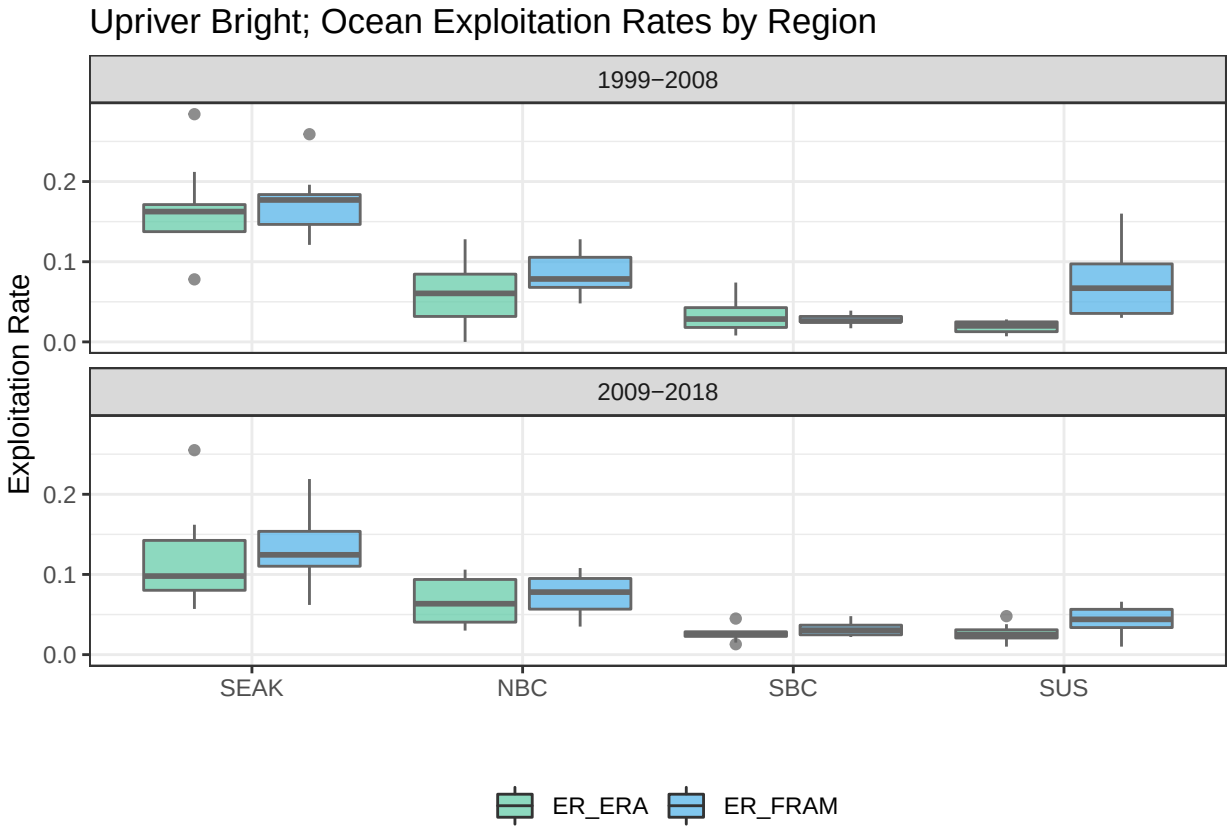

Columbia River Summer; Maturation Rates
2
3
4
5
Maturation Rate
0.010
0.005
0.000
0.15
0.10
0.05
0.00
0.6
0.4
0.2
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

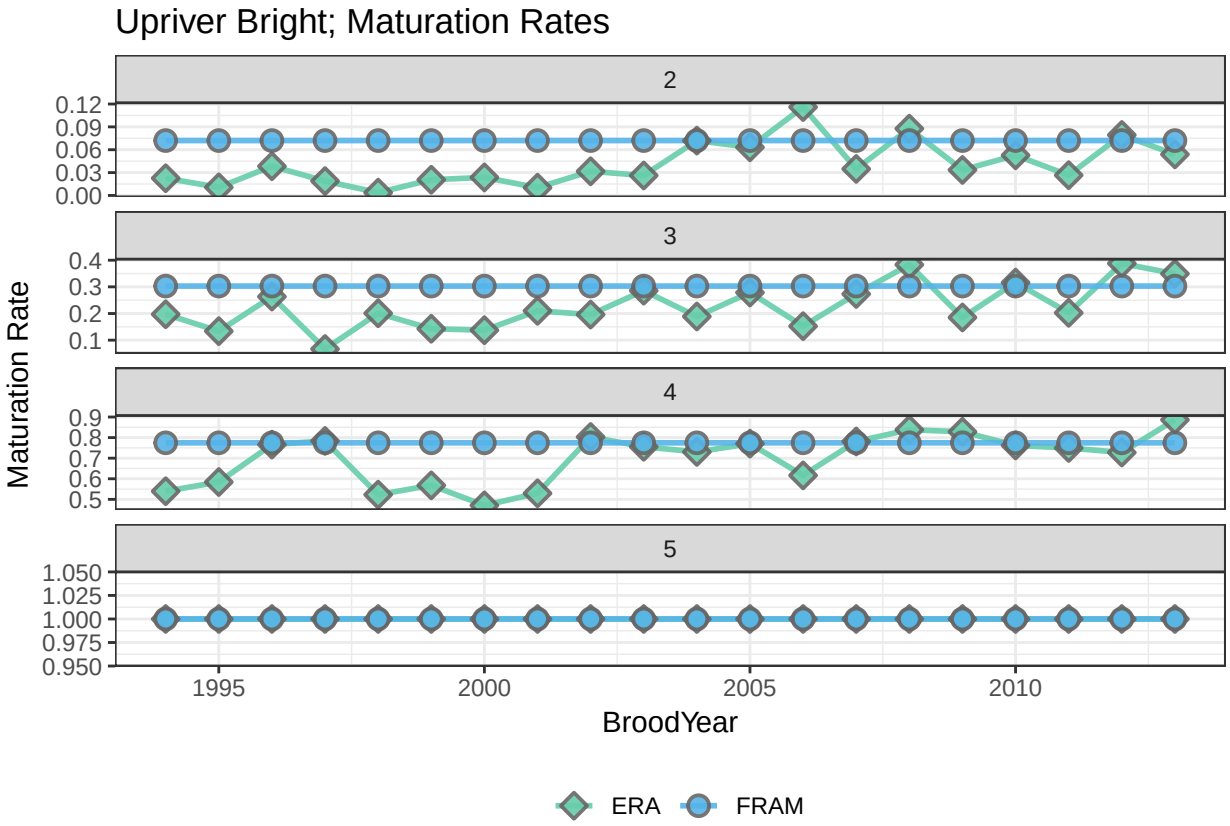
Stock	BroodYear	TagCode	ERA	FRAM
URB	2005	633173	x	x
URB	2006	094504	x	x
URB	2006	633894	x	x
URB	2007	094663	x	x
URB	2007	634391	x	x
URB	2008	634799	x	x

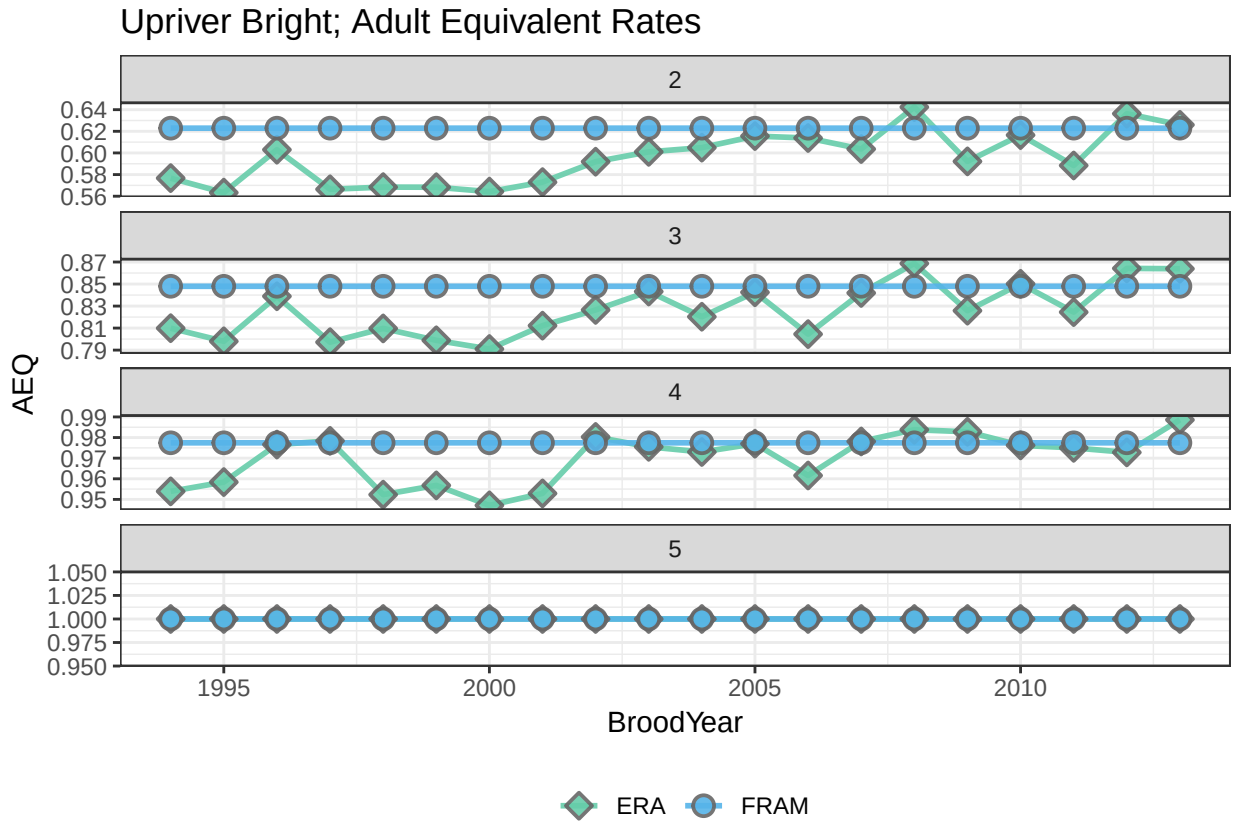


Upriver Bright


Upriver Bright; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.1
0.2
0.3
0.4
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

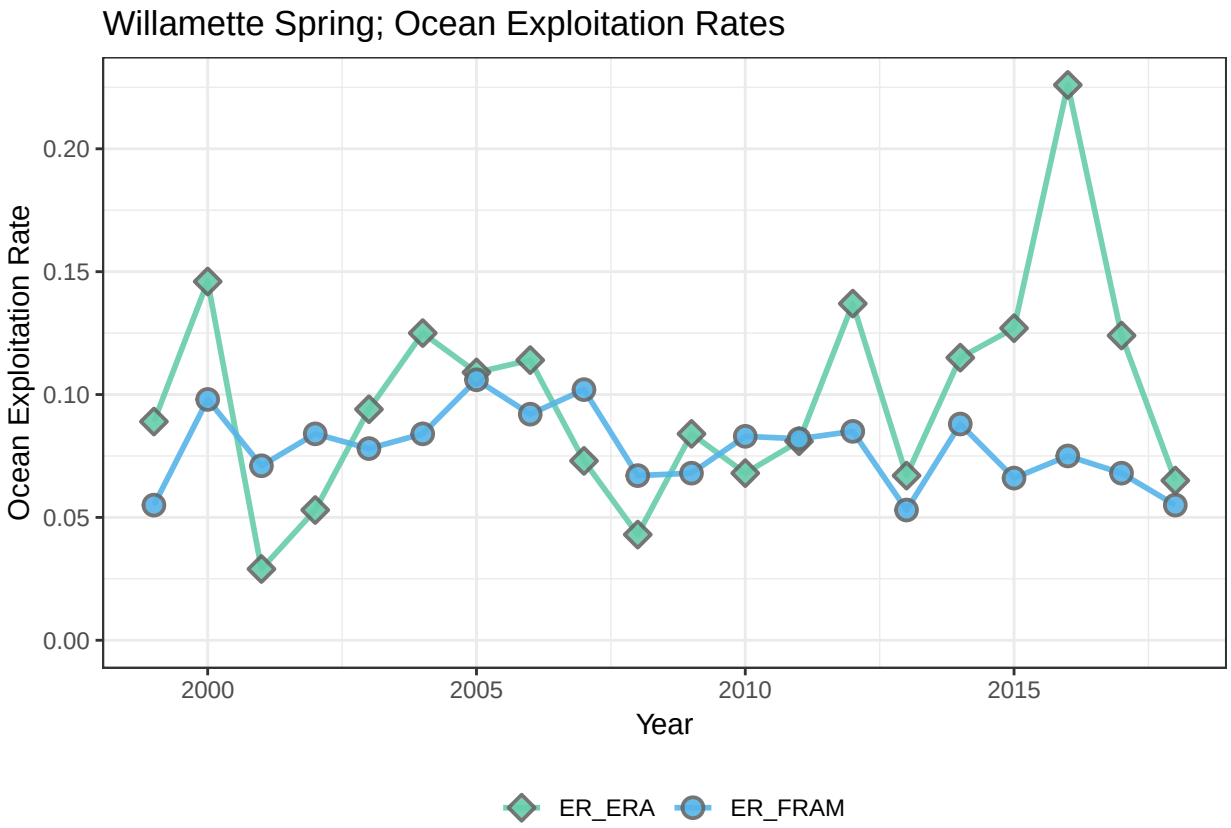

Upriver Bright; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

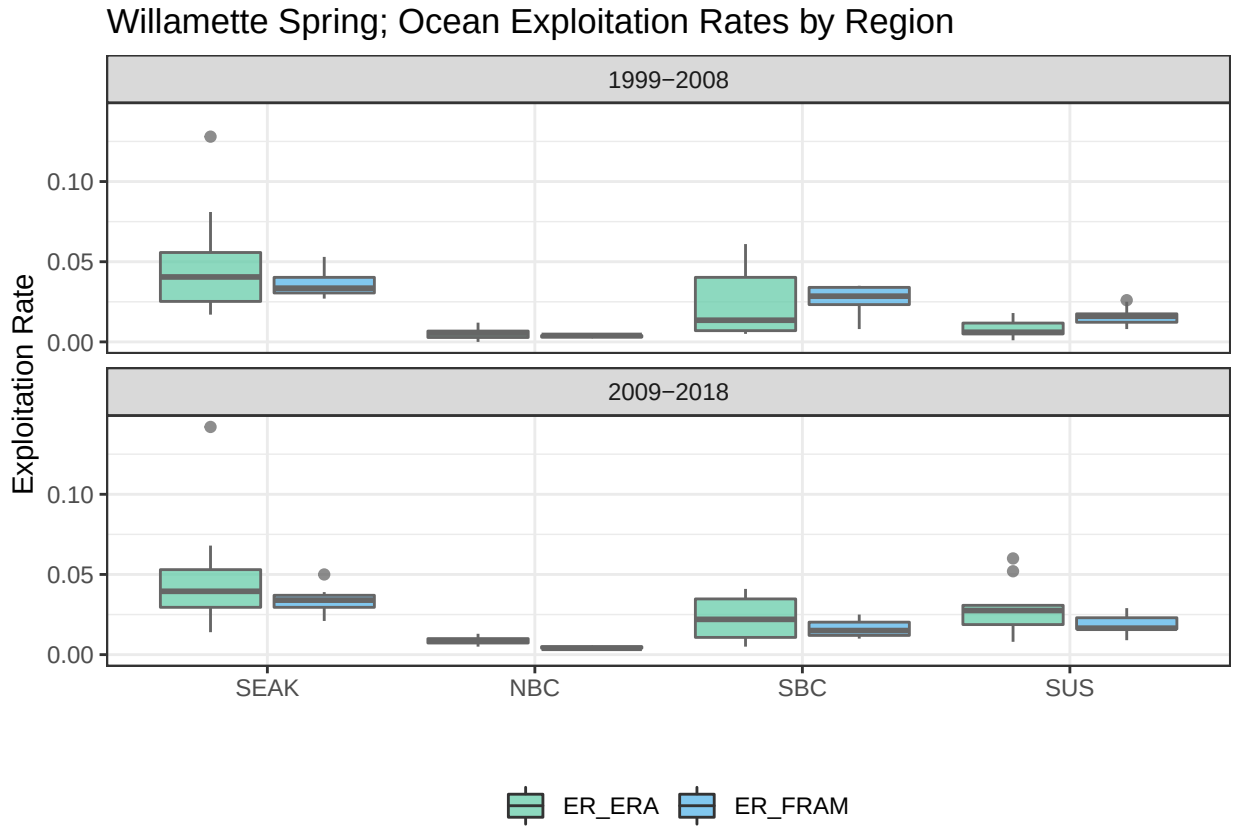

Upriver Bright; Maturation Rates
2
3
4
5
Maturation Rate
0.12
0.09
0.06
0.03
0.00
0.4
0.3
0.2
0.1
0.9
0.8
0.7
0.6
0.5
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM



Willamette Spring

Stock	BroodYear	TagCode	ERA	FRAM
WSH	2005	094422	x	x
WSH	2005	092734	x	x
WSH	2005	094143	x	x
WSH	2005	094453	x	x
WSH	2005	094142	x	x
WSH	2005	094344	x	x
WSH	2005	094436	x	x
WSH	2005	094438	x	x
WSH	2005	094345	x	x
WSH	2005	094019	x	
WSH	2005	094348	x	x
WSH	2005	094349	x	x
WSH	2005	094347	x	x
WSH	2005	094425	x	x
WSH	2005	094139		x
WSH	2005	094437		x
WSH	2005	094335		x
WSH	2005	094439		x
WSH	2005	094333		x
WSH	2005	094140		x
WSH	2005	094346		x
WSH	2006	094549	x	x
WSH	2006	094556	x	x
WSH	2006	094557	x	x
WSH	2006	094558	x	x
WSH	2006	094559	x	x
WSH	2006	094560	x	x
WSH	2006	094561	x	x
WSH	2006	094562	x	x
WSH	2006	094563	x	x
WSH	2006	094601	x	x
WSH	2006	094602	x	x
WSH	2006	094603	x	x
WSH	2006	094609	x	x
WSH	2006	094610	x	x
WSH	2006	094612	x	x
WSH	2006	094614	x	x
WSH	2006	094615	x	x
WSH	2006	094616	x	x
WSH	2006	094617	x	
WSH	2006	094627	x	x
WSH	2007	094650	x	x
WSH	2007	094529	x	x
WSH	2007	090169	x	x
WSH	2007	090171	x	x
WSH	2007	090177	x	x
WSH	2007	090178	x	x
WSH	2007	090188	x	x
WSH	2007	090190	x	x
WSH	2007	090189	x	x
WSH	2007	090187	x	x
WSH	2007	094657	x	x
WSH	2007	094652		x
WSH	2007	094651		x
WSH	2008	090193	x	x
WSH	2008	090269	x	x
WSH	2008	090238	x	x


Willamette Spring; Ocean Exploitation Rates
Ocean Exploitation Rate
0.00
0.05
0.10
0.15
0.20
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

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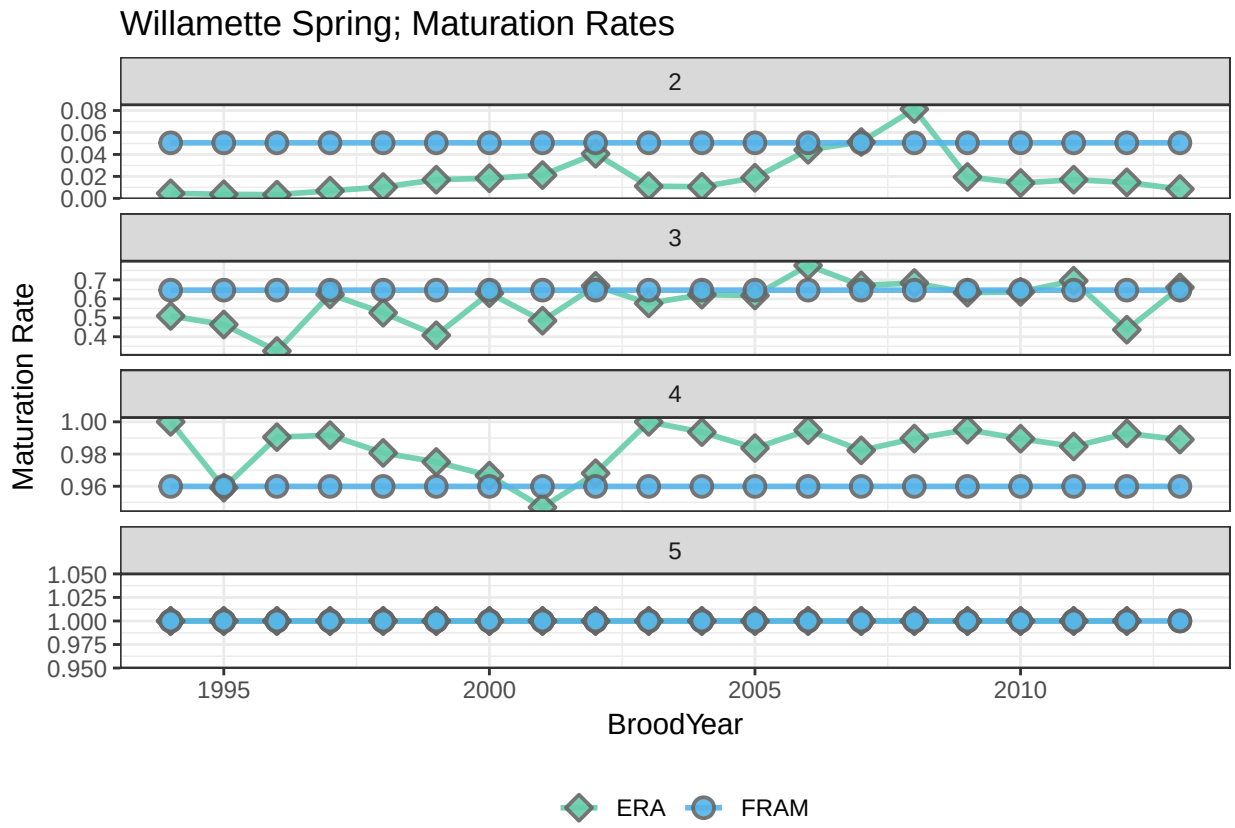
## Warning: Removed 2 rows containing missing values (geom_path).
```

```
## Warning: Removed 2 rows containing missing values (geom_point).
```




```
## Warning: Removed 1 rows containing missing values (geom_point).
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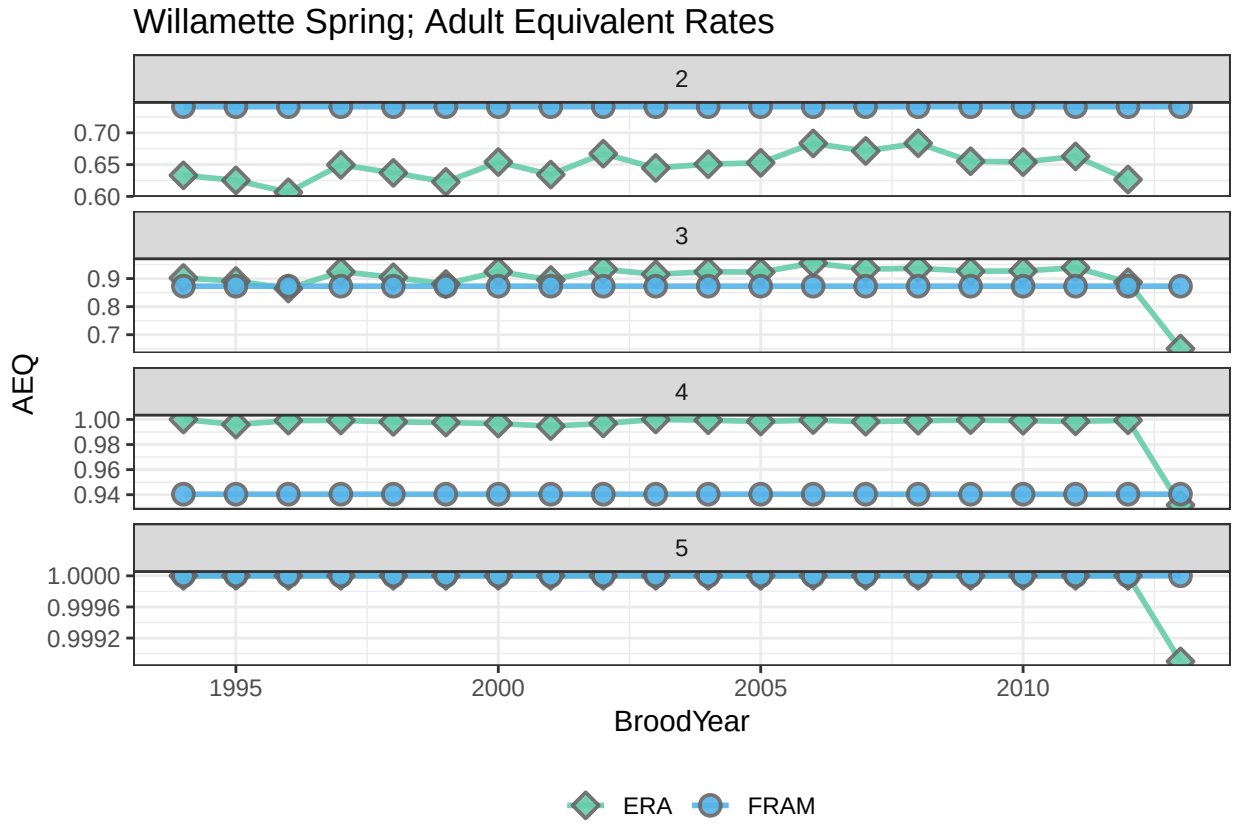
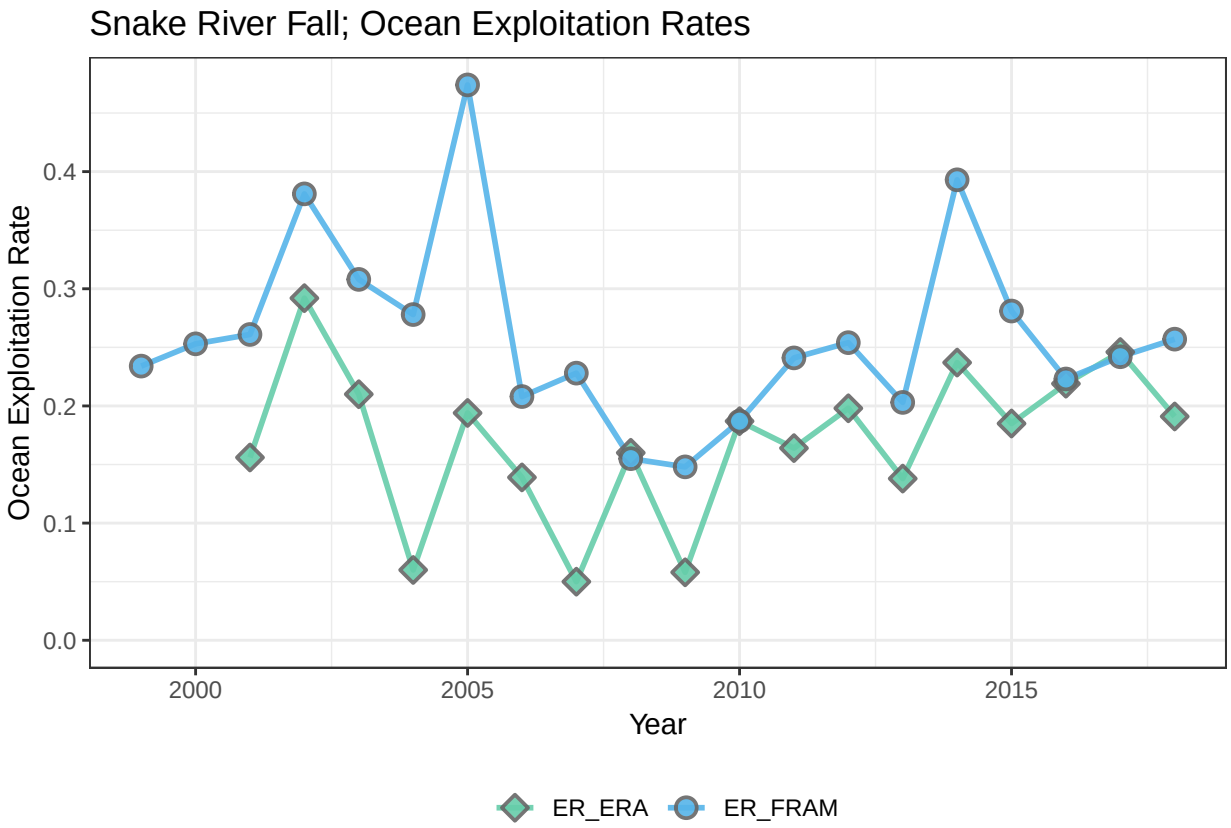
Stock	BroodYear	TagCode	ERA	FRAM
LYF	2005	633582	x	x
LYF	2005	633598		x
LYF	2006	633986	x	x
LYF	2006	633987		x
LYF	2007	634672	x	x
LYF	2007	634671		x
LYF	2007	634680		x
LYF	2008	634995	x	x
LYF	2008	635166		x

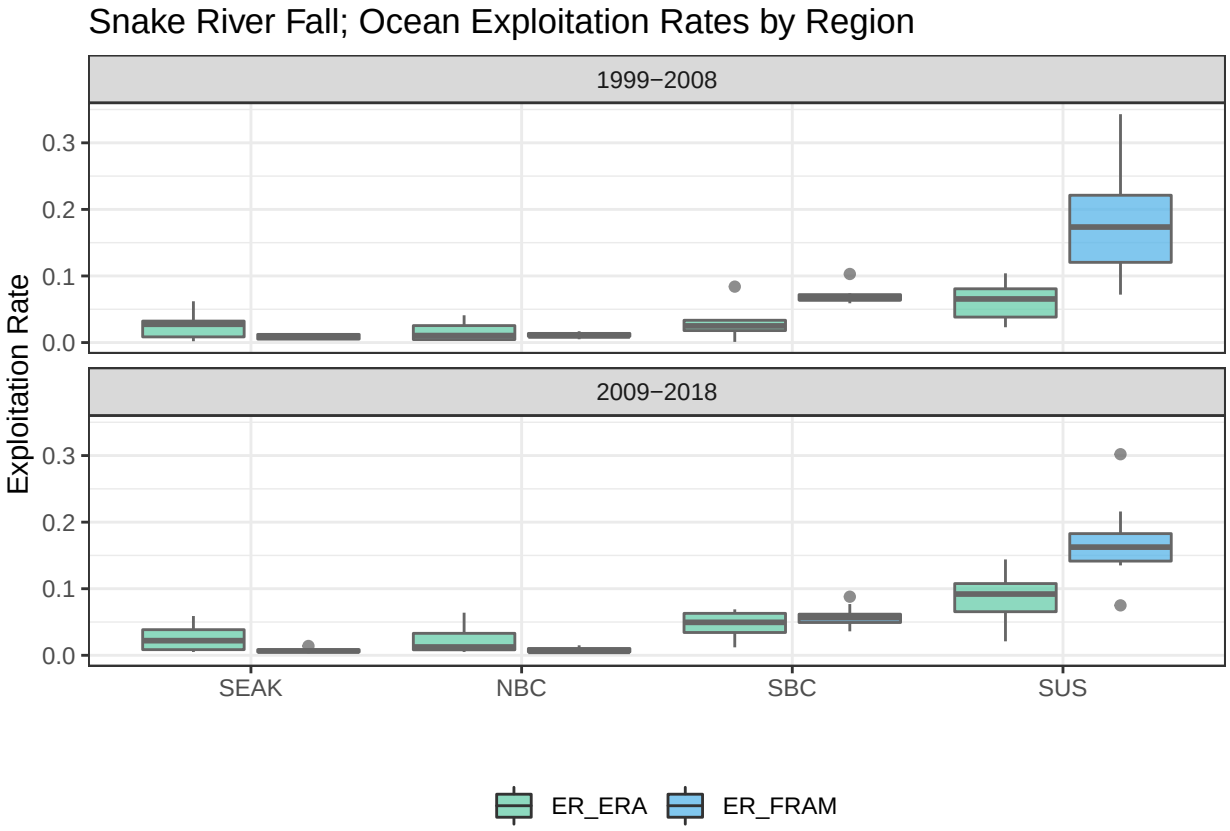


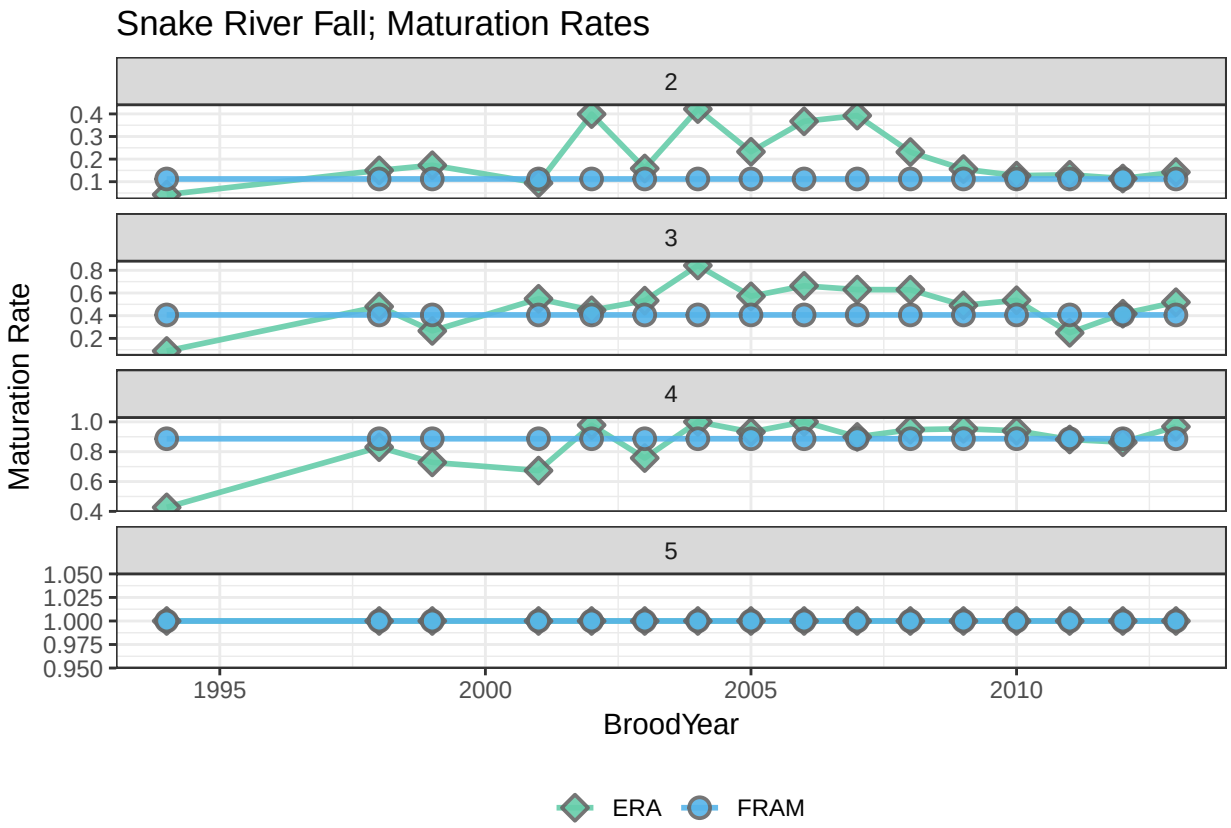
Snake River Fall

```
## Warning: Removed 2 rows containing missing values (geom_path).
```

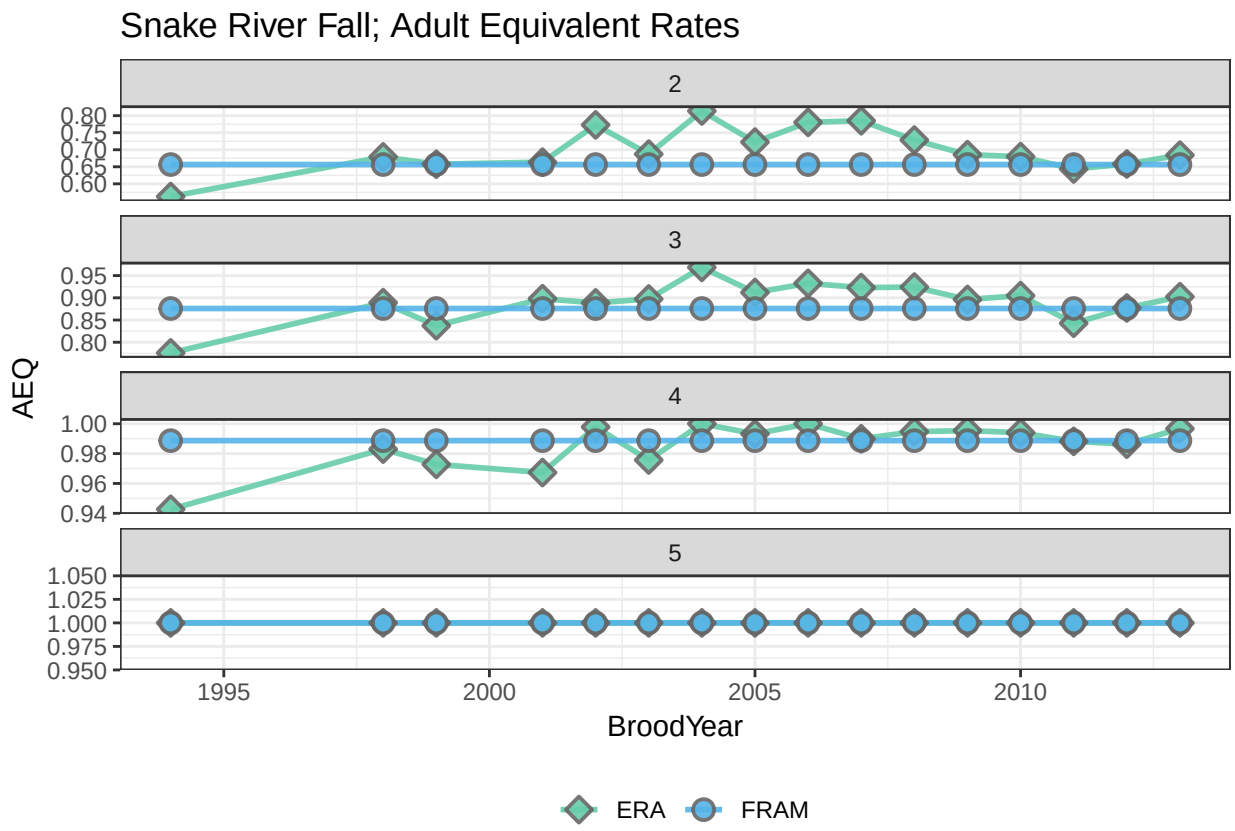
```
## Warning: Removed 2 rows containing missing values (geom_point).
```


Snake River Fall; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.1
0.2
0.3
0.4
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

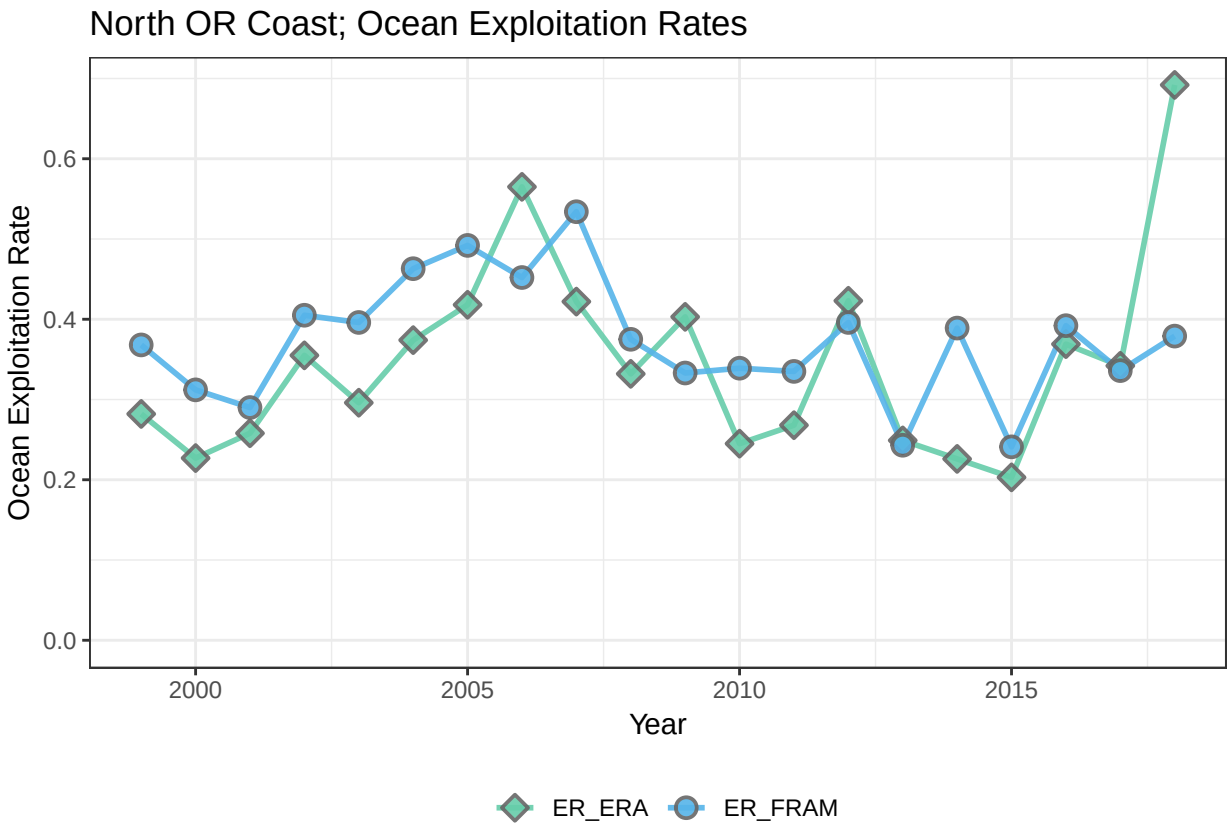

Snake River Fall; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

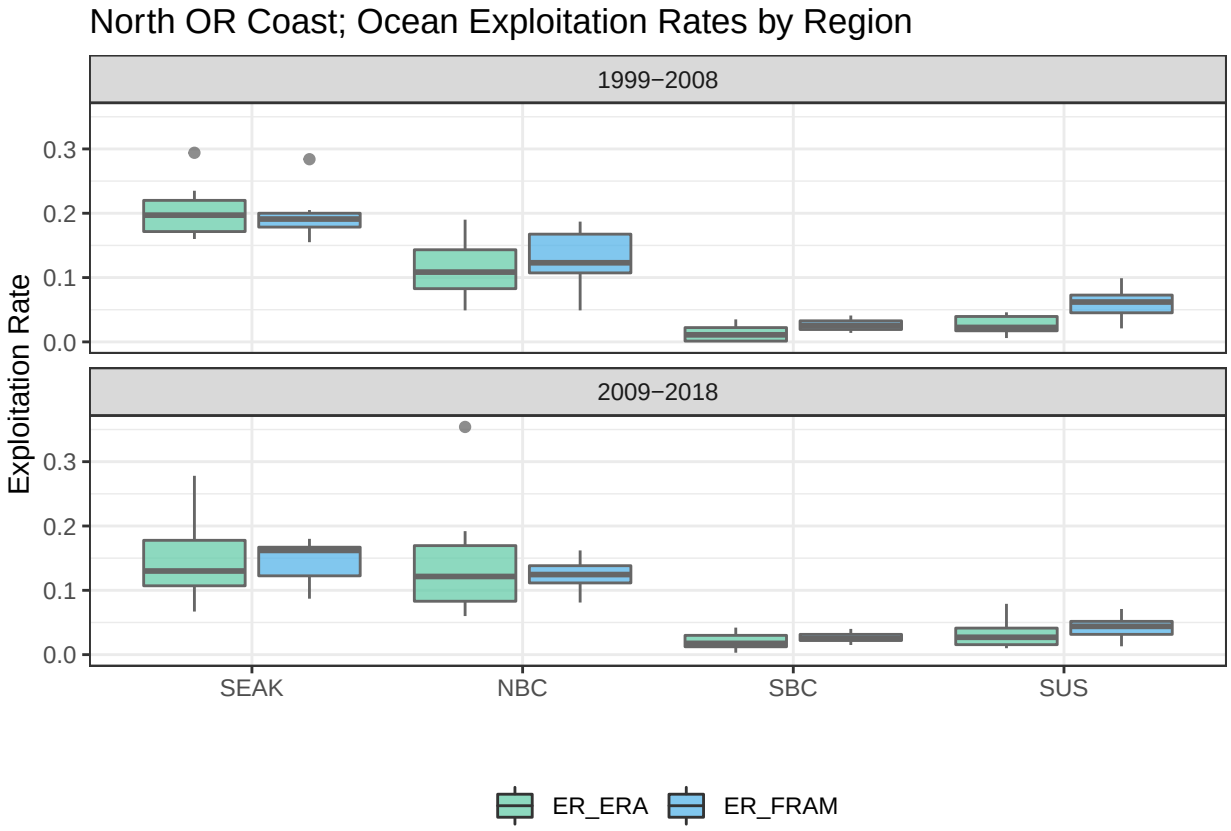

Snake River Fall; Maturation Rates
2
3
4
5
Maturation Rate
0.4
0.3
0.2
0.1
0.8
0.6
0.4
0.2
1.0
0.8
0.6
0.4
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

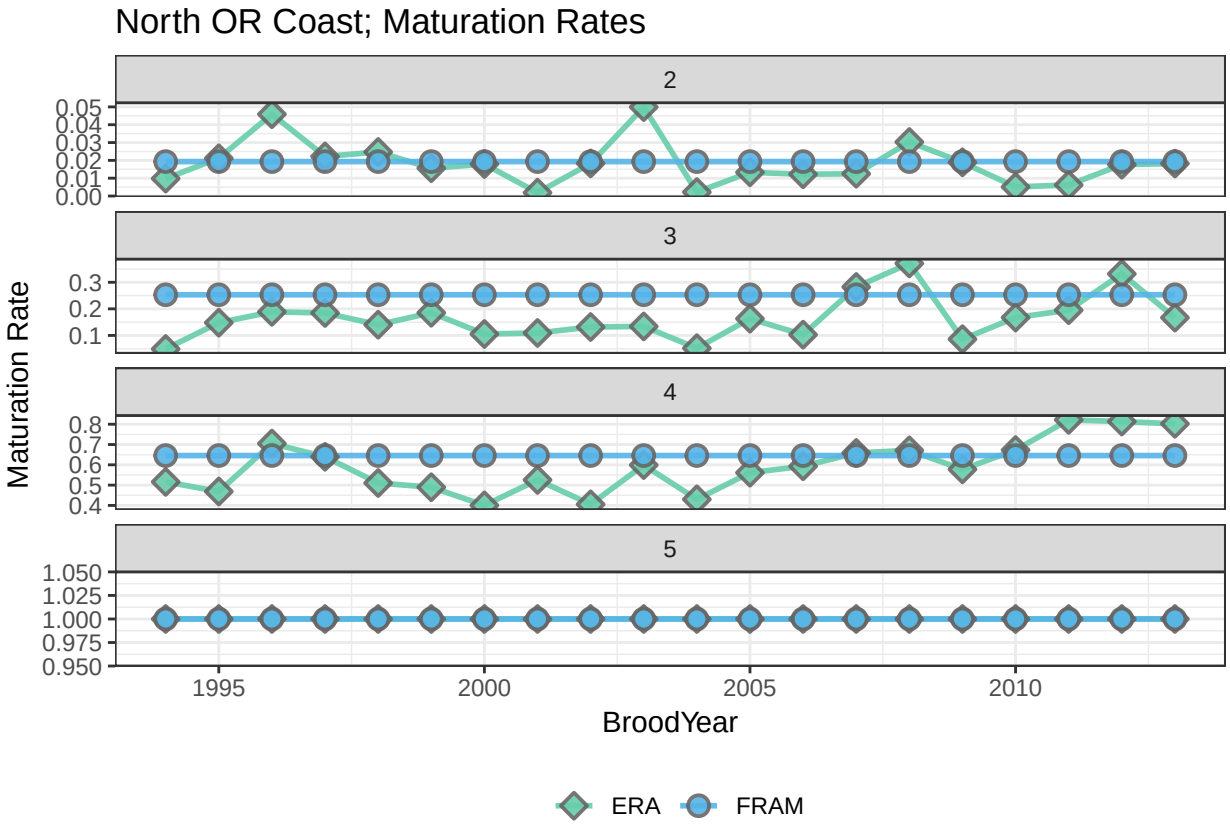
Stock	BroodYear	TagCode	ERA	FRAM
SRH	2005	094428	x	x
SRH	2006	094525	x	x
SRH	2007	094645	x	x
SRH	2008	094701	x	x

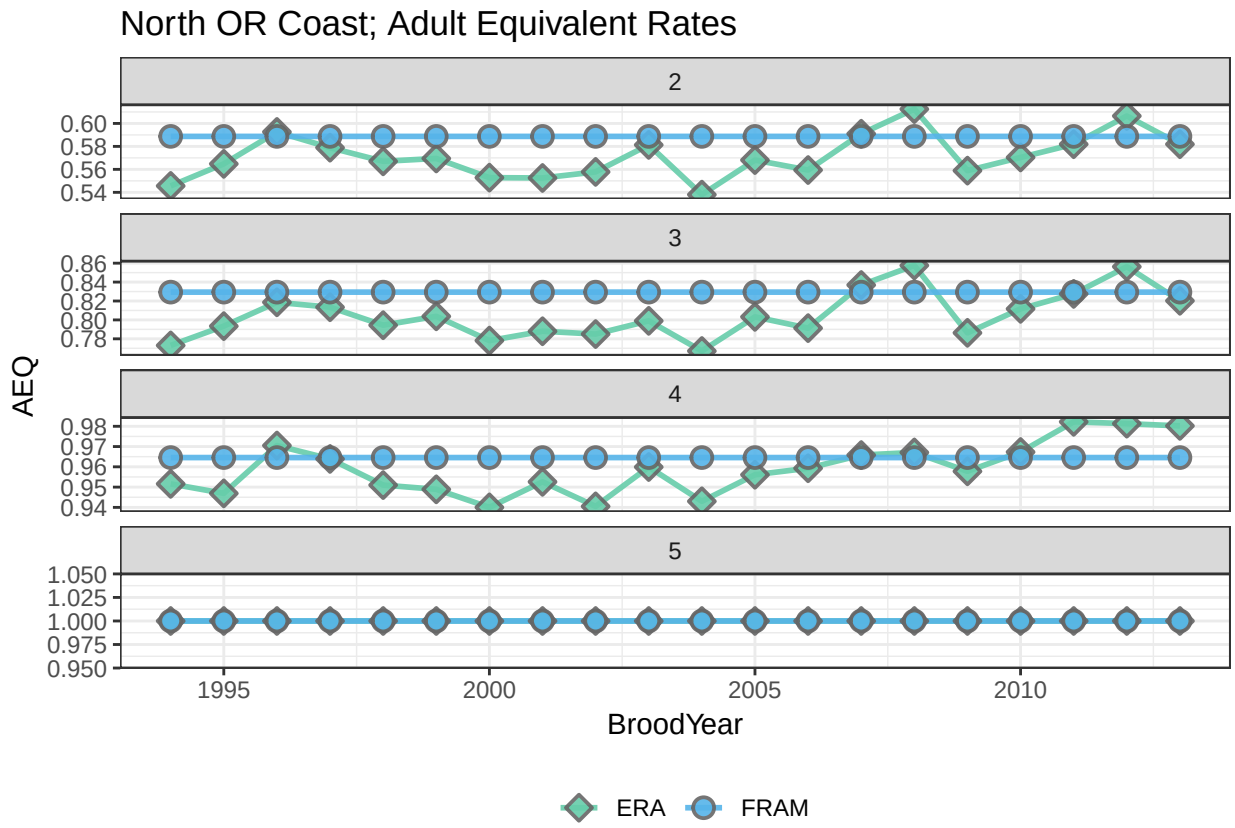


North OR Coast


North OR Coast; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.2
0.4
0.6
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

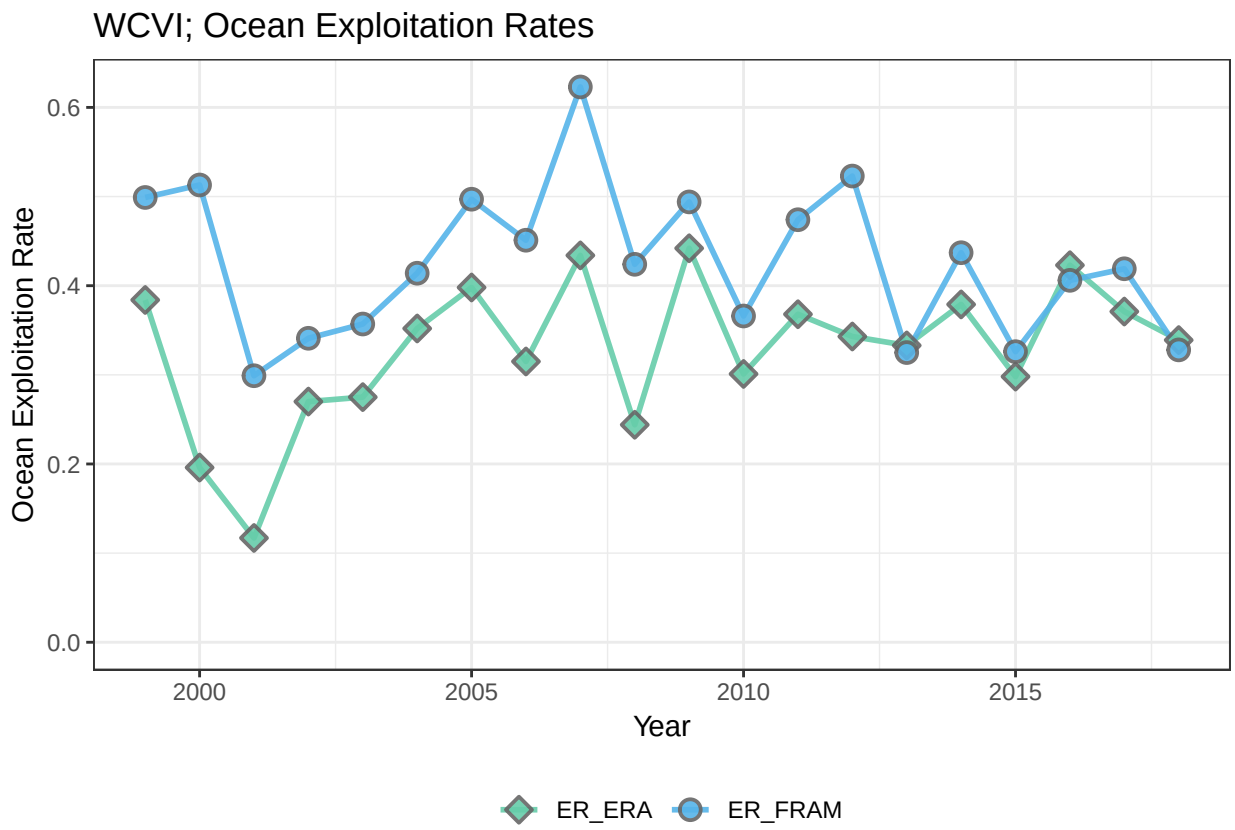

North OR Coast; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

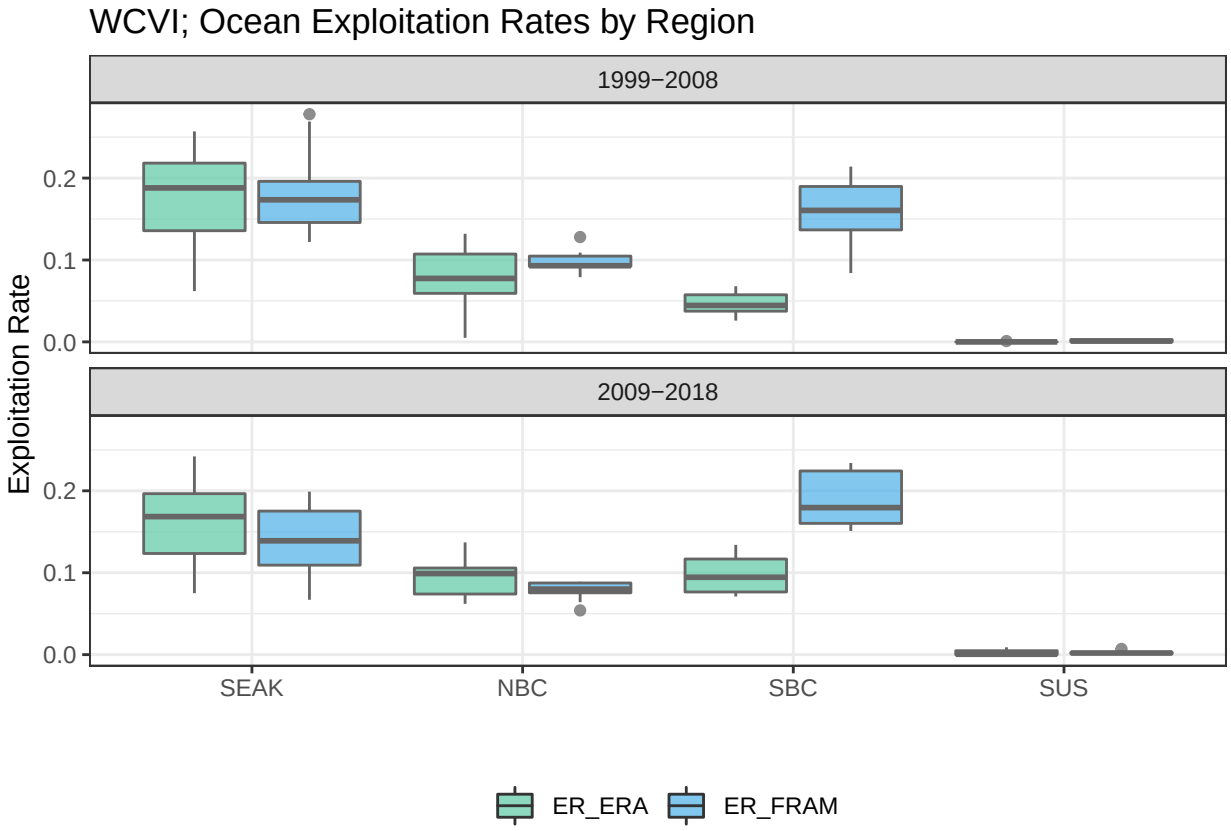

North OR Coast; Maturation Rates
2
3
4
5
Maturation Rate
0.05
0.04
0.03
0.02
0.01
0.00
0.3
0.2
0.1
0.8
0.7
0.6
0.5
0.4
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

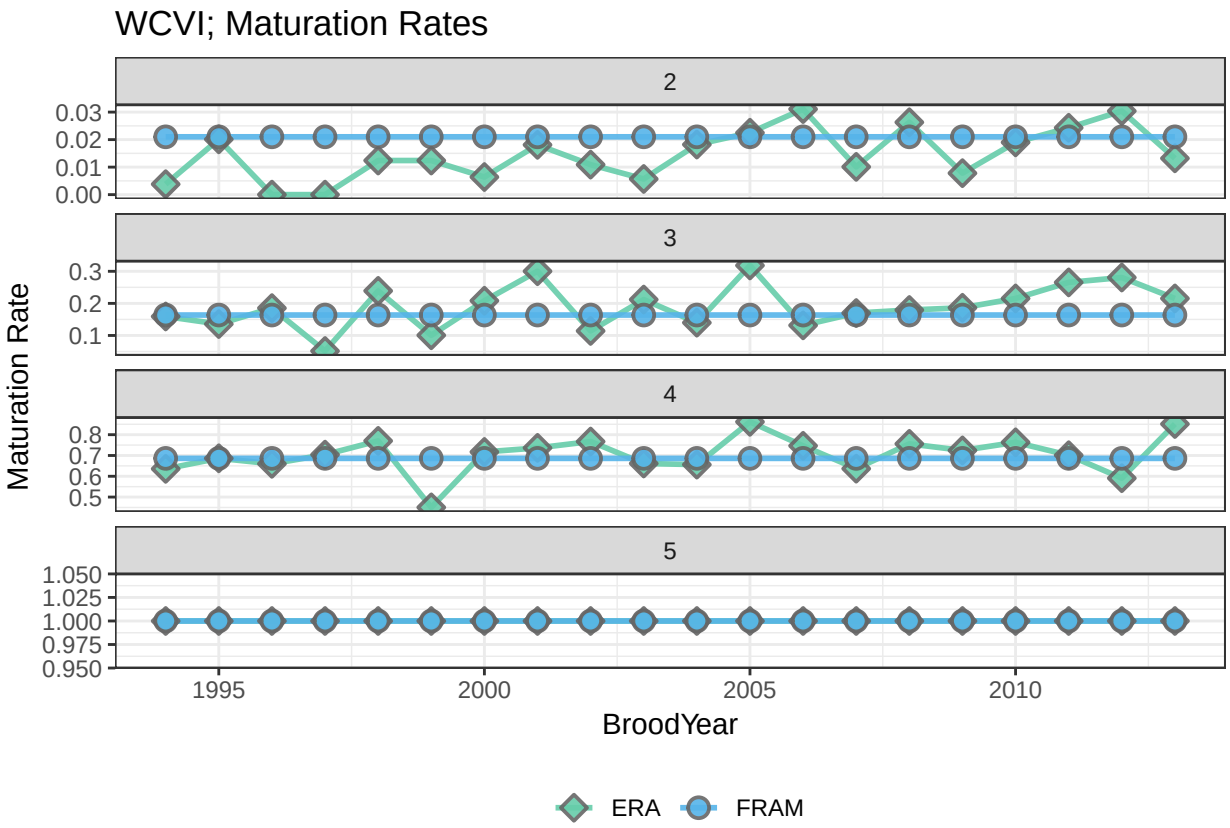

North OR Coast; Adult Equivalent Rates
2
3
4
5
AEQ
0.60
0.58
0.56
0.54
0.86
0.84
0.82
0.80
0.78
0.98
0.97
0.96
0.95
0.94
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

WCVI

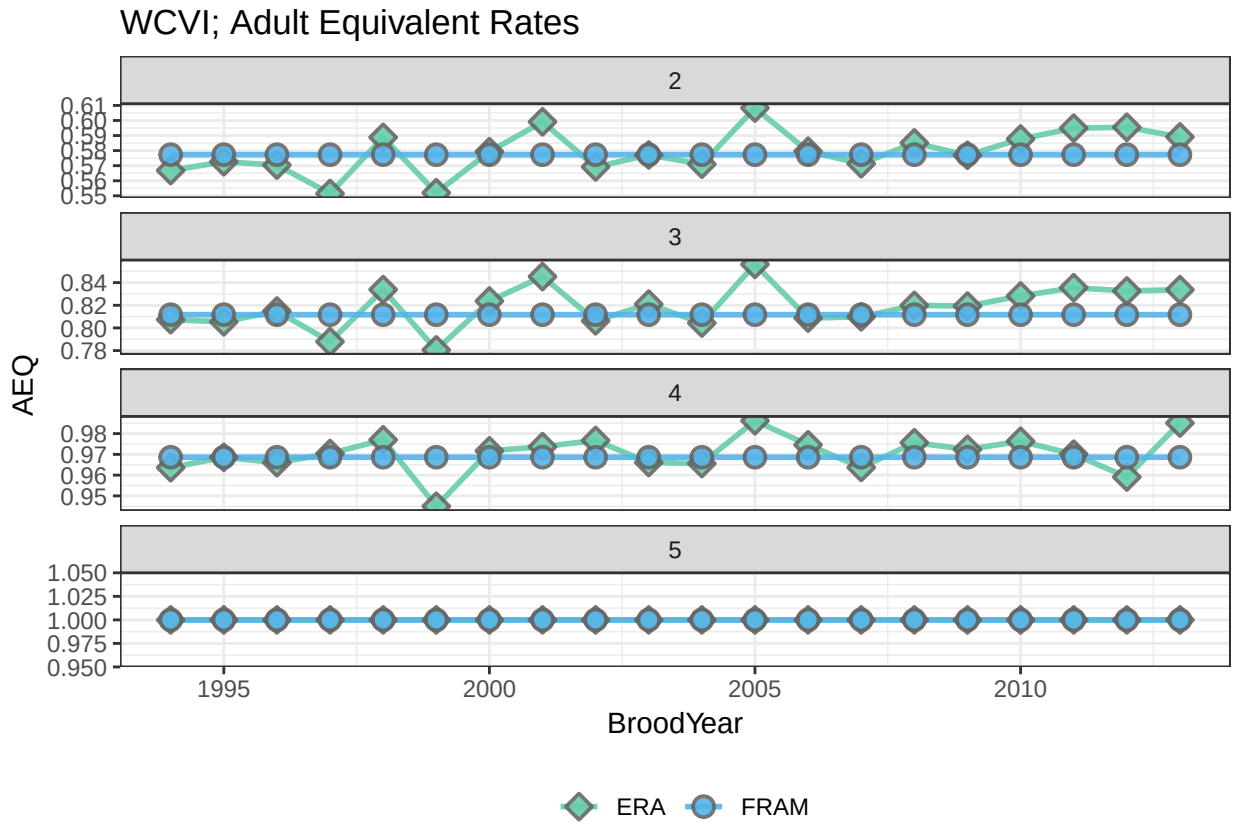
Stock	BroodYear	TagCode	ERA	FRAM
RBT	2005	185257	x	x
RBT	2005	185258	x	x
RBT	2005	185259	x	x
RBT	2005	185260	x	x
RBT	2005	185948	x	x
RBT	2005	185949	x	x
RBT	2005	185950	x	x
RBT	2005	185951	x	x
RBT	2006	185821	x	x
RBT	2006	185822	x	x
RBT	2006	185823	x	x
RBT	2006	185824	x	x
RBT	2006	185825	x	x
RBT	2006	185826	x	x
RBT	2006	185827	x	x
RBT	2006	185828	x	x
RBT	2007	186134	x	x
RBT	2007	186301	x	x
RBT	2007	186302	x	x
RBT	2007	186303	x	x
RBT	2007	186304	x	x
RBT	2007	186305	x	x
RBT	2007	186306	x	x
RBT	2007	186343	x	x
RBT	2007	186344	x	x
RBT	2008	180386	x	x
RBT	2008	180387	x	x
RBT	2008	180388	x	x
RBT	2008	180389	x	x
RBT	2008	180390	x	x
RBT	2008	180391	x	x
RBT	2008	180392	x	x
RBT	2008	180393	x	x
RBT	2008	180394	x	x
RBT	2008	180685	x	x
RBT	2008	180881	x	x
RBT	2008	180882	x	x
RBT	2008	180883	x	x
RBT	2008	180884	x	x
RBT	2008	180885	x	x
RBT	2008	185960	x	x
RBT	2008	185961	x	x
RBT	2008	185962	x	x


WCVI; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.2
0.4
0.6
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

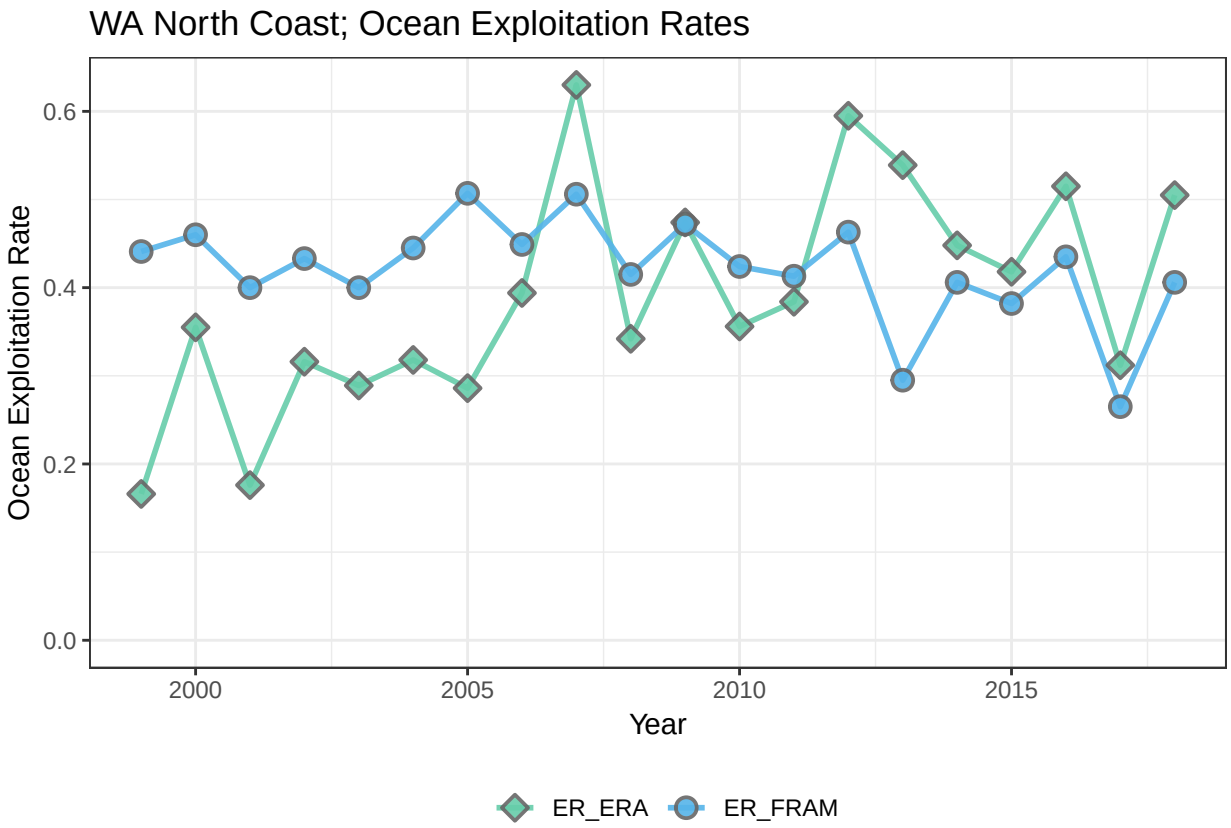

WCVI; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

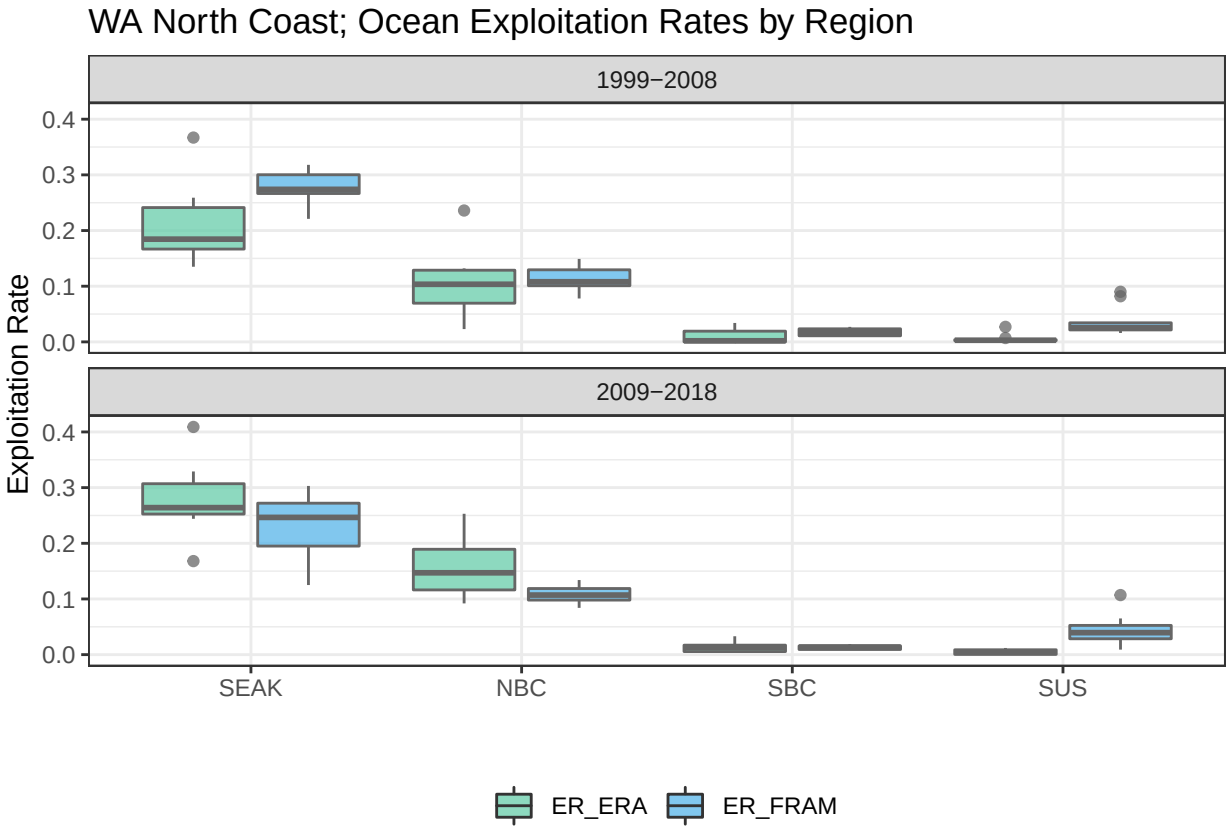

WCVI; Maturation Rates
2
3
4
5
Maturation Rate
0.03
0.02
0.01
0.00
0.3
0.2
0.1
0.8
0.7
0.6
0.5
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

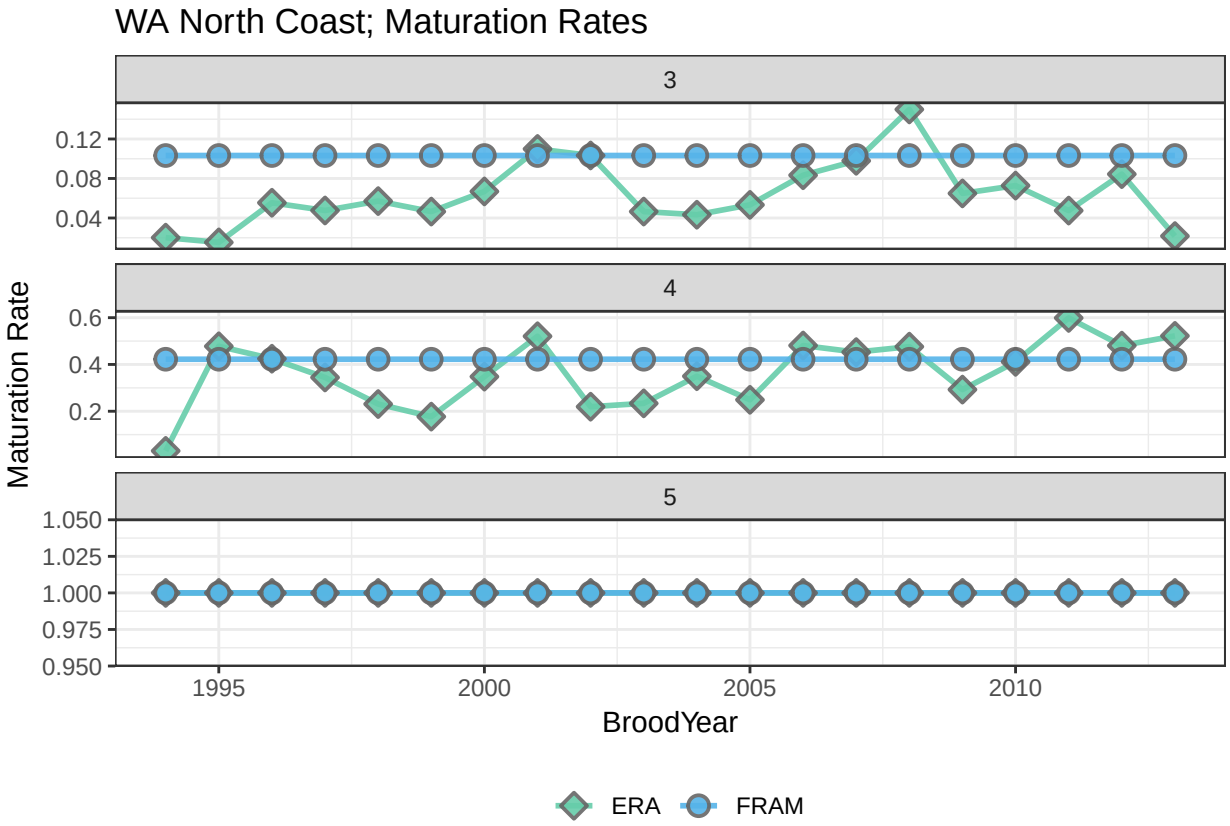
Stock	BroodYear	TagCode	ERA	FRAM
QUE	2005	210679	x	x
QUE	2006	210738	x	x
QUE	2007	210791	x	x
QUE	2008	210843	x	x



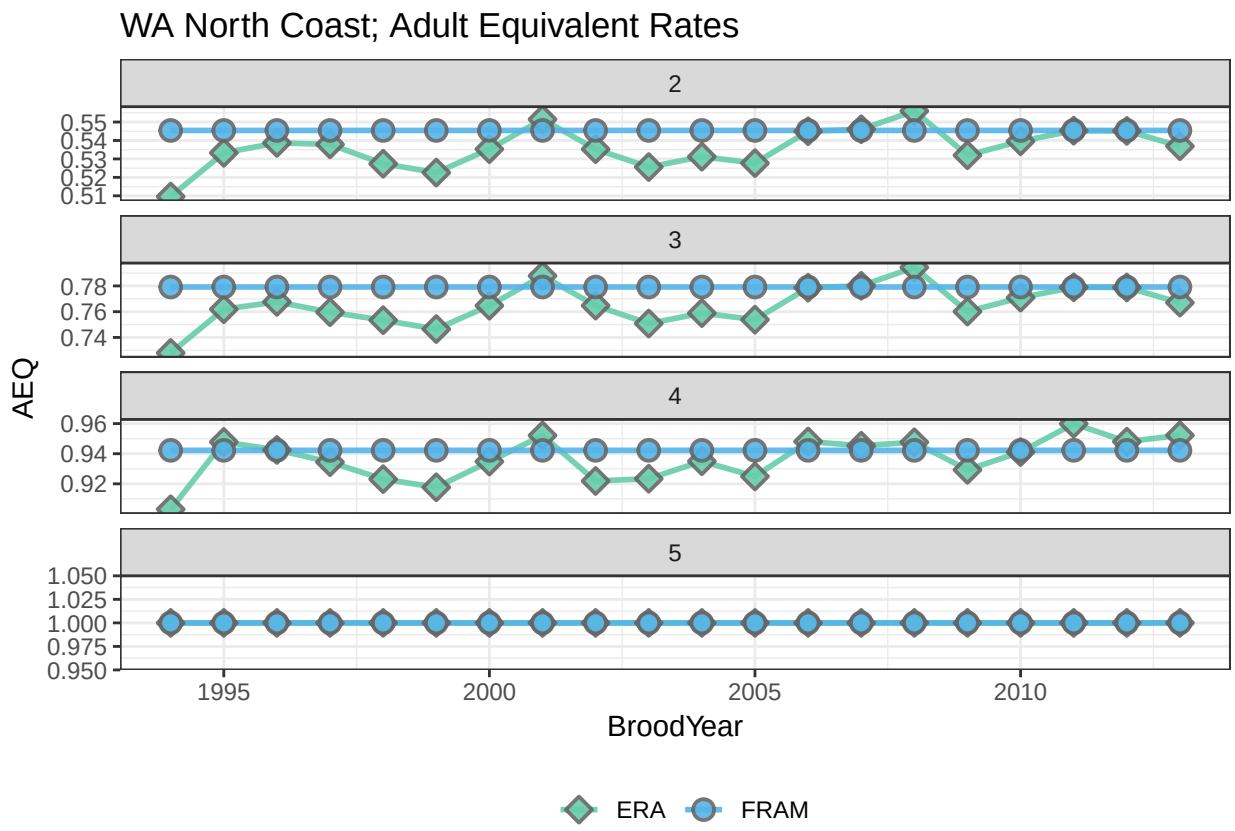
WA North Coast


WA North Coast; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.2
0.4
0.6
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM

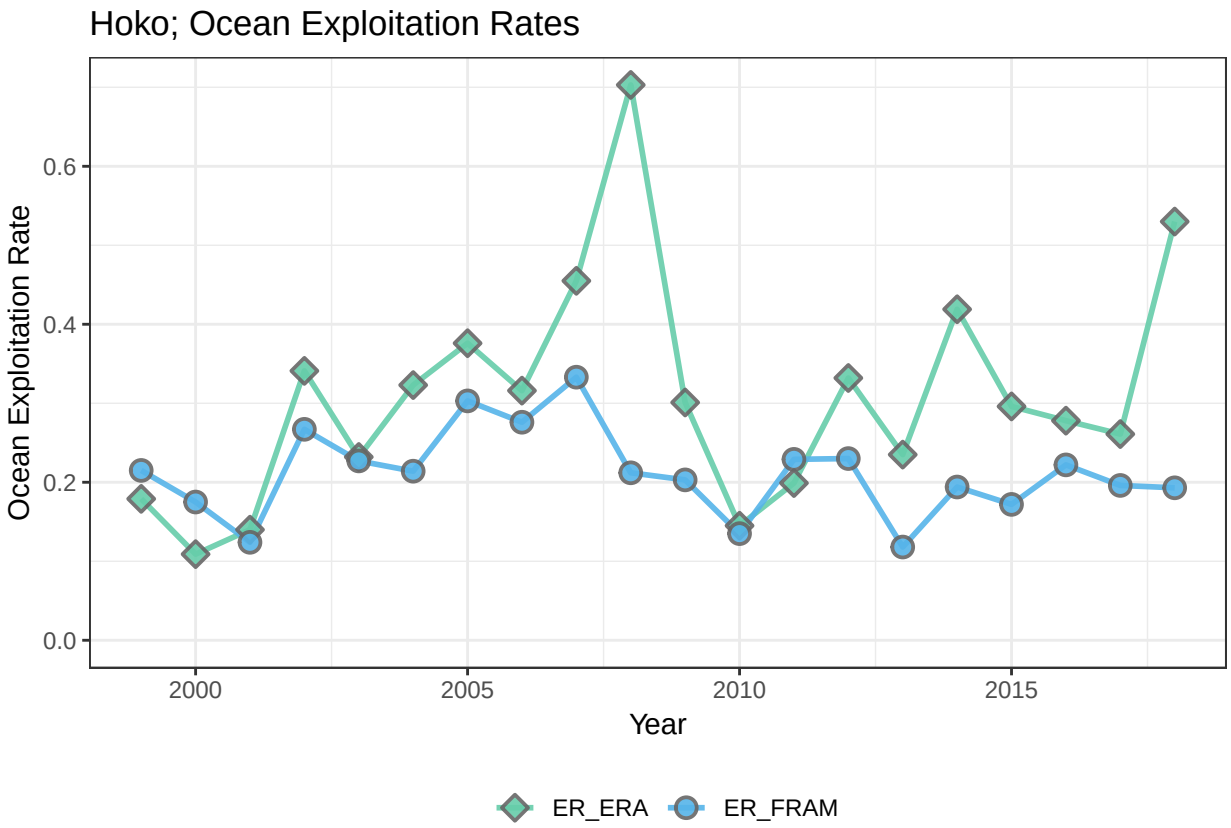

WA North Coast; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
0.4
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM

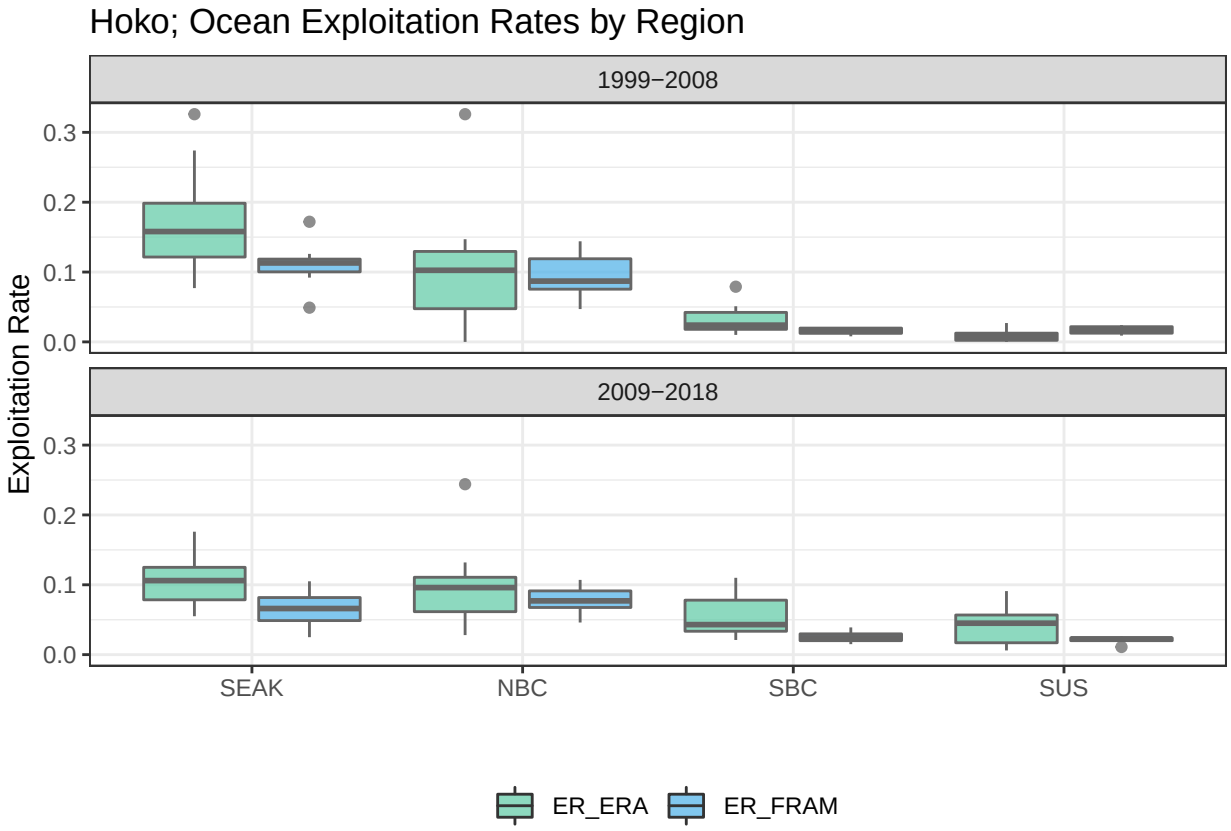

WA North Coast; Maturation Rates
3
4
5
Maturation Rate
0.12
0.08
0.04
0.6
0.4
0.2
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM

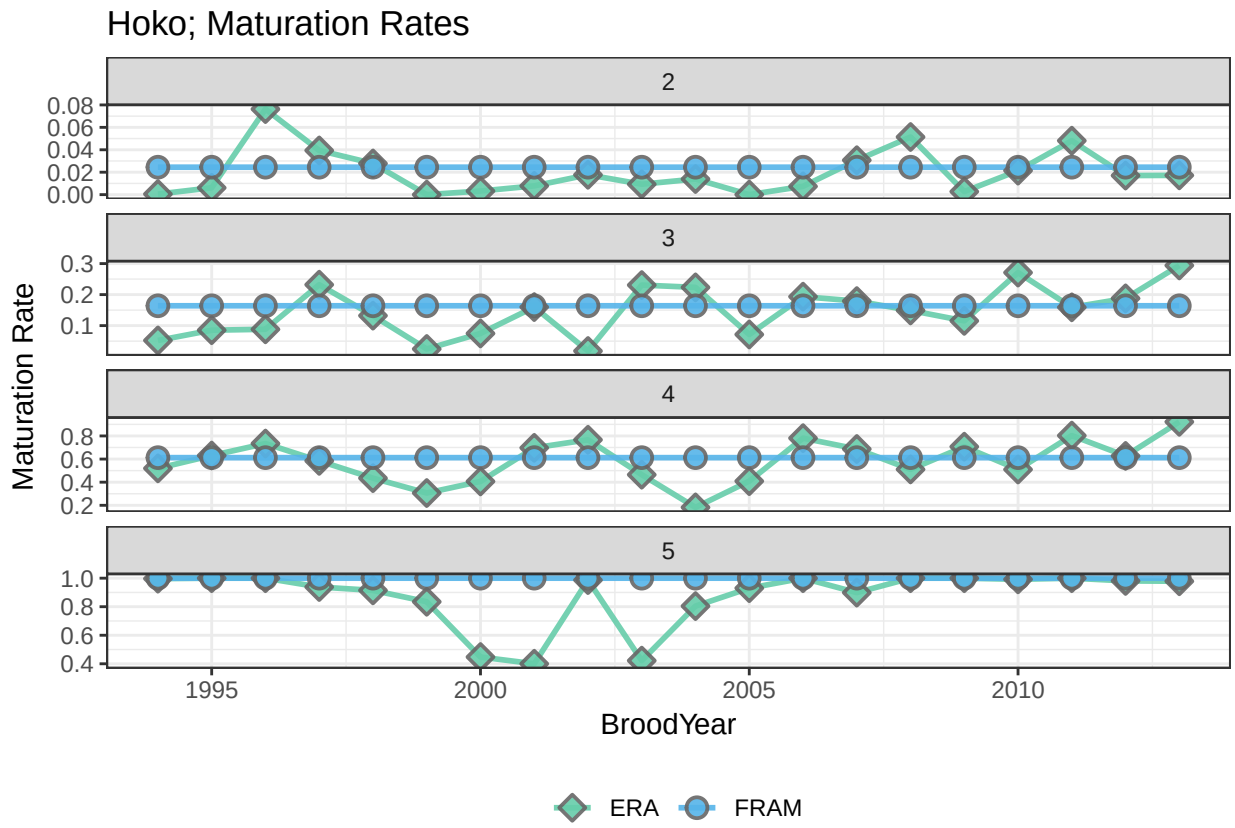
Stock	BroodYear	TagCode	ERA	FRAM
HOK	2005	210678	x	x
HOK	2006	210739	x	x
HOK	2007	210786	x	x
HOK	2008	210841	x	x



Hoko


Hoko; Ocean Exploitation Rates
Ocean Exploitation Rate
0.0
0.2
0.4
0.6
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM


Hoko; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.0
0.1
0.2
0.3
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM




```
## Warning: Removed 1 rows containing missing values (geom_point).
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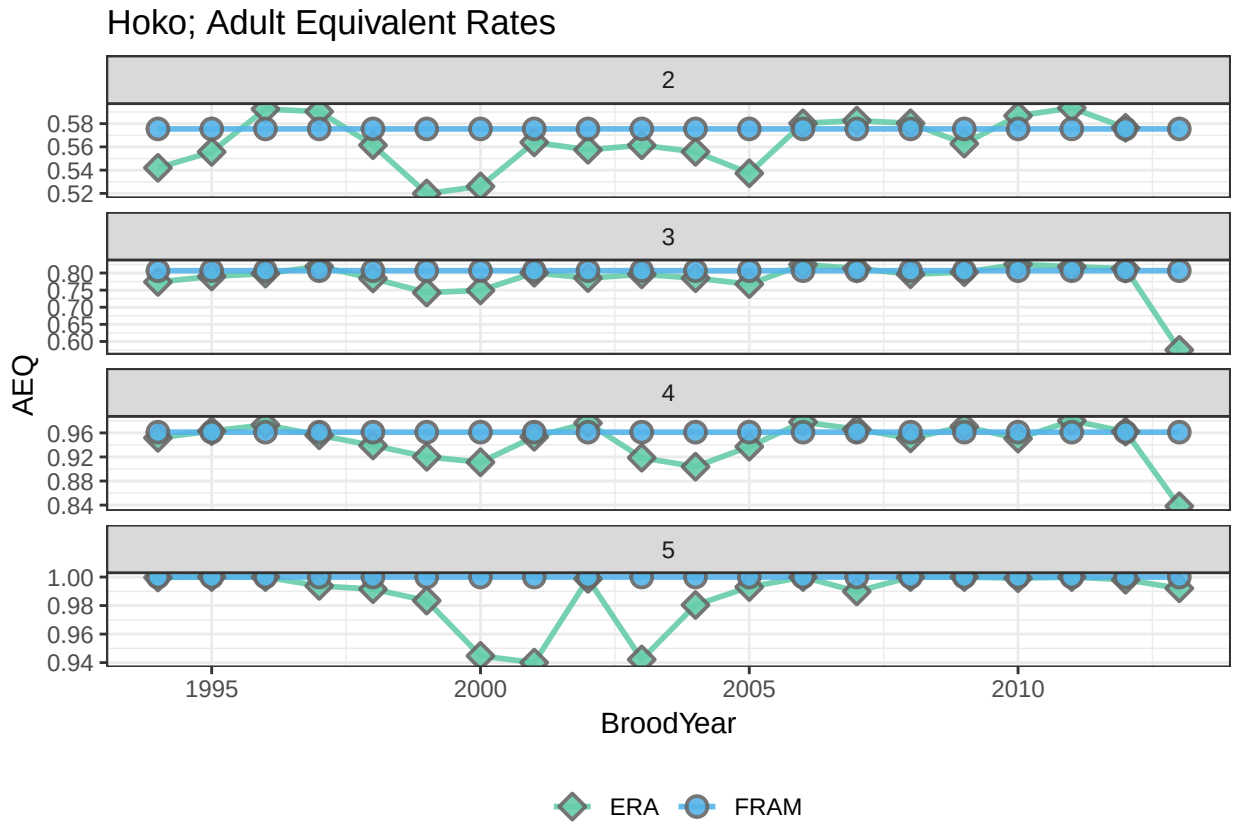
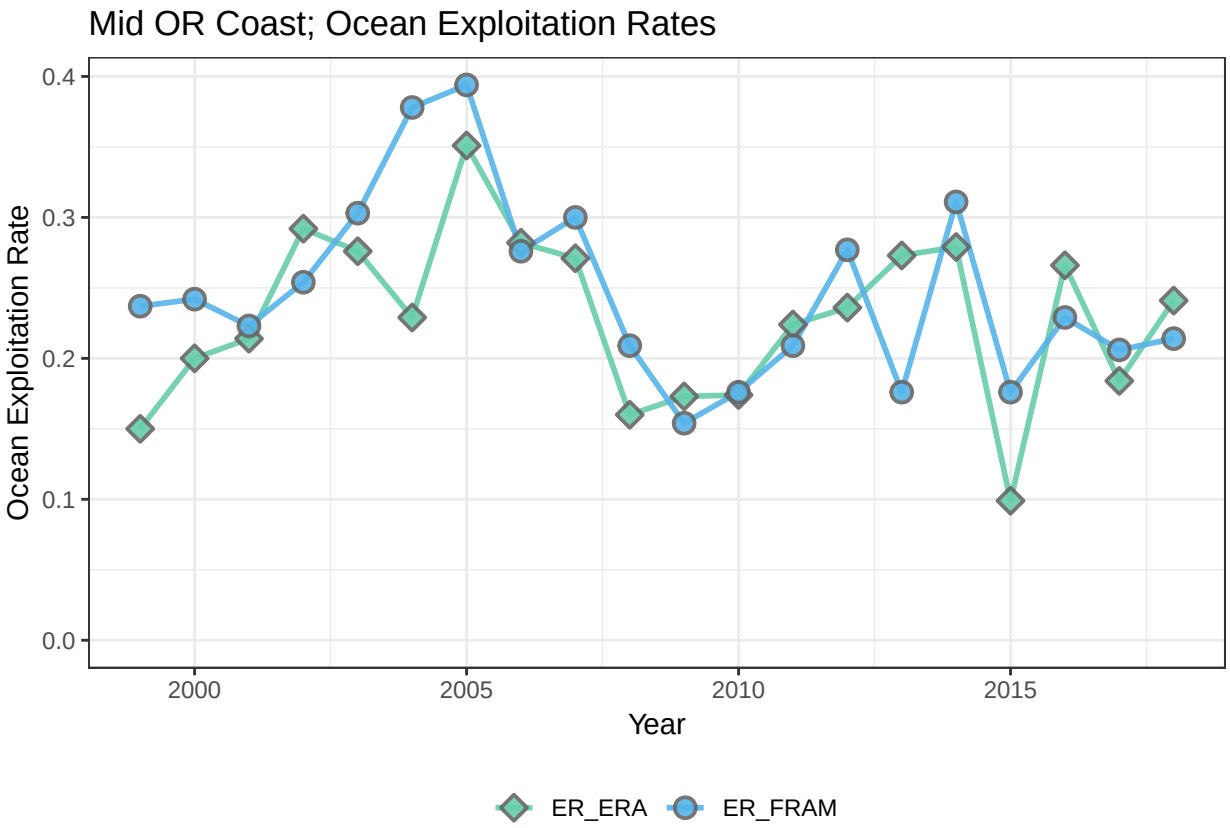
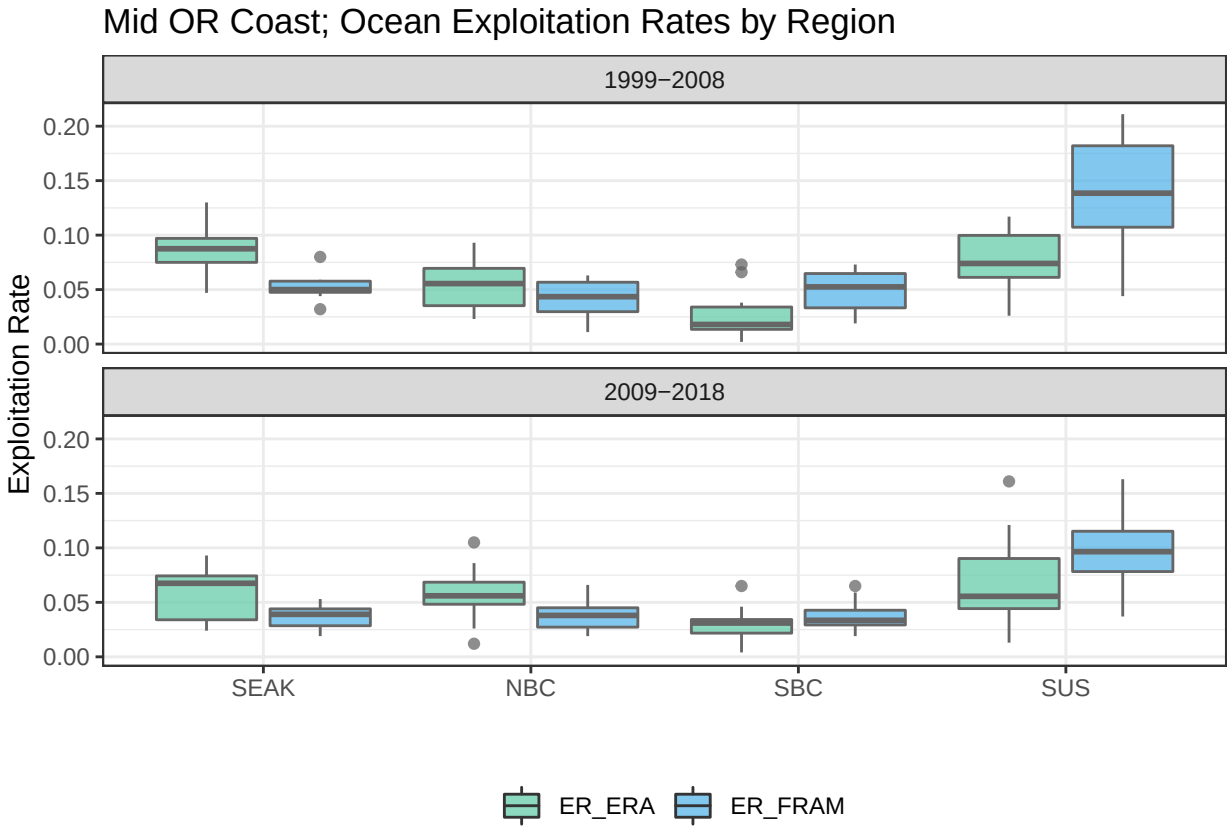
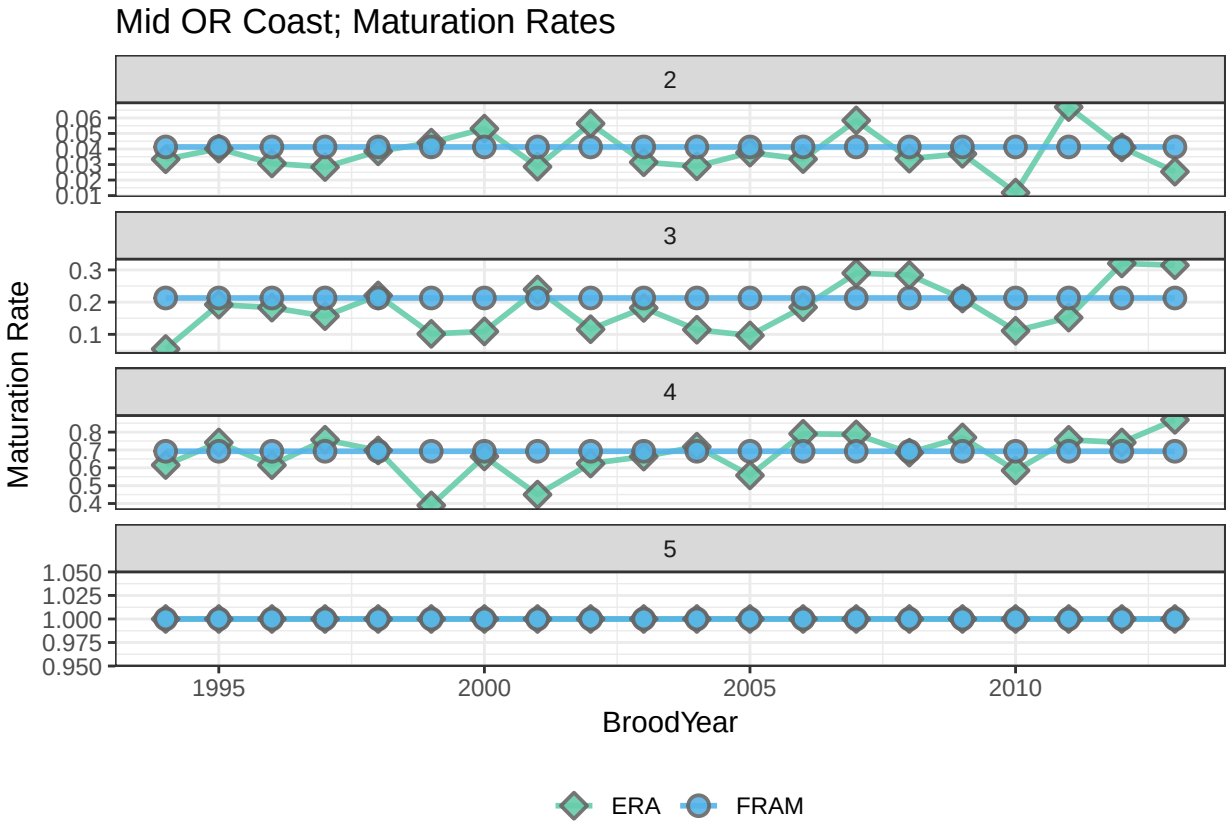
Stock	BroodYear	TagCode	ERA	FRAM
ELK	2005	094343	x	x
ELK	2006	094643	x	x
ELK	2007	090157	x	x
ELK	2007	090165	x	x
ELK	2008	093938	x	x

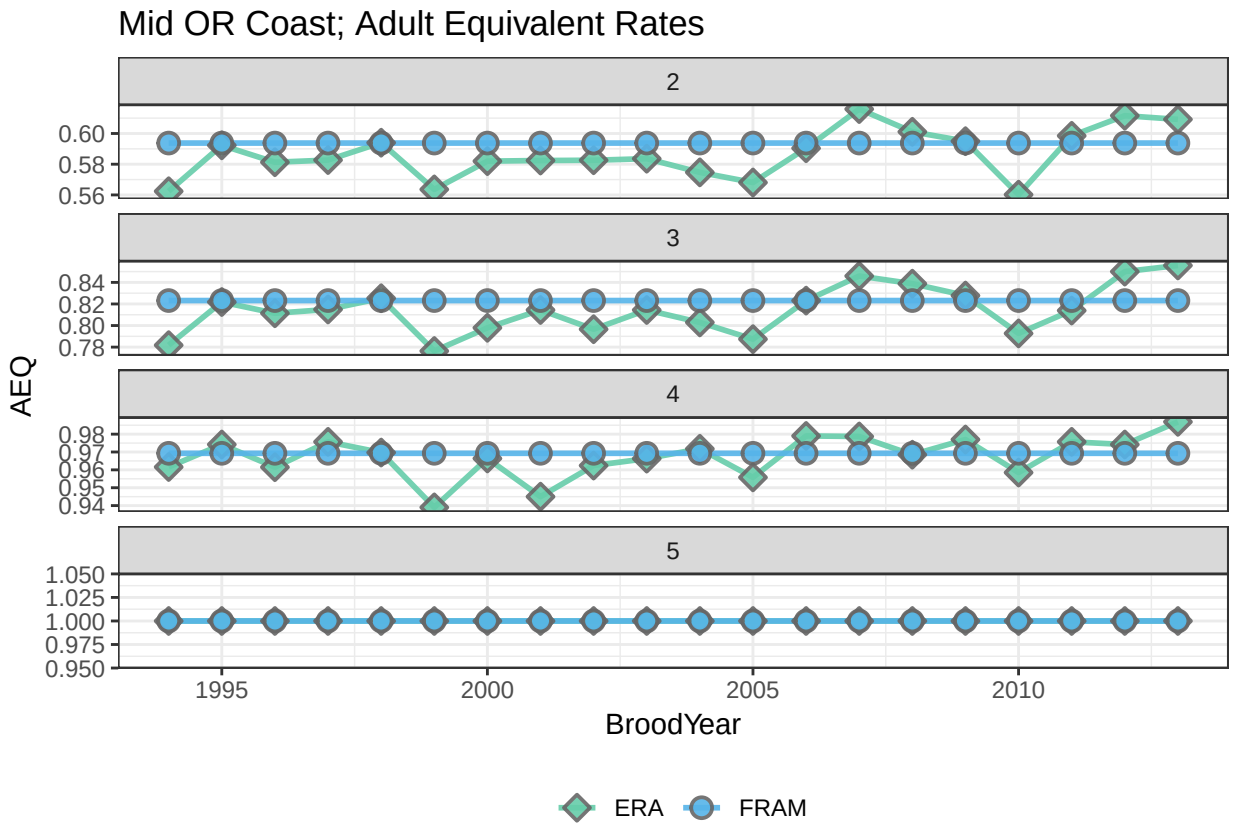


Mid OR Coast


Mid OR Coast; Ocean Exploitation Rates
Ocean Exploitation Rate
0.4
0.3
0.2
0.1
0.0
2000
2005
2010
2015
Year
ER_ERA
ER_FRAM


Mid OR Coast; Ocean Exploitation Rates by Region
1999−2008
2009−2018
Exploitation Rate
0.00
0.05
0.10
0.15
0.20
SEAK
NBC
SBC
SUS
ER_ERA
ER_FRAM


Mid OR Coast; Maturation Rates
2
3
4
5
Maturation Rate
0.06
0.05
0.04
0.03
0.02
0.01
0.3
0.2
0.1
0.8
0.7
0.6
0.5
0.4
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM


Mid OR Coast; Adult Equivalent Rates
2
3
4
5
AEQ
0.60
0.58
0.56
0.84
0.82
0.80
0.78
0.98
0.97
0.96
0.95
0.94
1.050
1.025
1.000
0.975
0.950
1995
2000
2005
2010
BroodYear
ERA
FRAM