



**NOAA
FISHERIES**

Update assessment for northern subpopulation Pacific sardine for fishing year 2022-2023

Peter Kuriyama, Juan Zwolinski, Kevin Hill
NOAA Fisheries, SWFSC

Update assessment

- Northern subpopulation of Pacific sardine
- Same model configuration as 2020 benchmark assessment
- Semester-based model
 - S1 (July-December); S2 (January-June)
- Fleet configurations
 - MexCal_S1 (Ensenada, Mexico; southern and central California)
 - MexCal_S2 (same regions, different time period)
 - PNW (Oregon; Washington; British Columbia, Canada)

Data updates

- Catch through model year-semester 2021-1 (July-December 2021).
- Fishery Age compositions for 2020-2, 2021-1
- AT survey index updates 2020-2, 2021-1
 - Survey age compositions for 2021-1
 - No spring age compositions included (as in 2020 benchmark)

Regional landings

Calendar Y-S	Model Y-S	ENS Total	ENS NSP	SCA Total	SCA NSP	CCA	OR	WA	BC
2015-1	2014-2	16,496.60	-	1,543.20	-	727.70	2,131.30	62.60	-
2015-2	2015-1	20,971.90	-	1,420.90	-	6.10	0.10	66.10	-
2016-1	2015-2	23,536.70	-	423.40	184.80	1.10	1.30	-	-
2016-2	2016-1	42,532.10	-	964.50	49.40	234.10	2.70	170.40	-
2017-1	2016-2	28,211.90	6,935.80	513.10	144.70	0.10	0.10	-	-
2017-2	2017-1	99,966.60	-	1,205.40	-	170.40	1.20	-	-
2018-1	2017-2	25,720.60	9,736.30	395.30	197.80	-	2.20	-	-
2018-2	2018-1	38,049.30	-	1,424.20	-	35.30	5.80	2.00	-
2019-1	2018-2	30,118.90	11,634.30	749.70	546.80	58.10	2.50	-	-
2019-2	2019-1	64,295.20	-	869.50	49.30	174.30	7.70	0.50	-
2020-1	2019-2	74,817.30	29,555.30	681.40	144.20	328.50	0.10	-	-
2020-2	2020-1	74,686.80	-	1,203.70	113.50	428.80	0.40	-	-
2021-1	2020-2	56,274.10	48,005.40	601.70	269.60	37.30	2.90	-	-
2021-2	2021-1	86,643.20	-	1,093.00	89.90	2.90	8.60	2.70	-

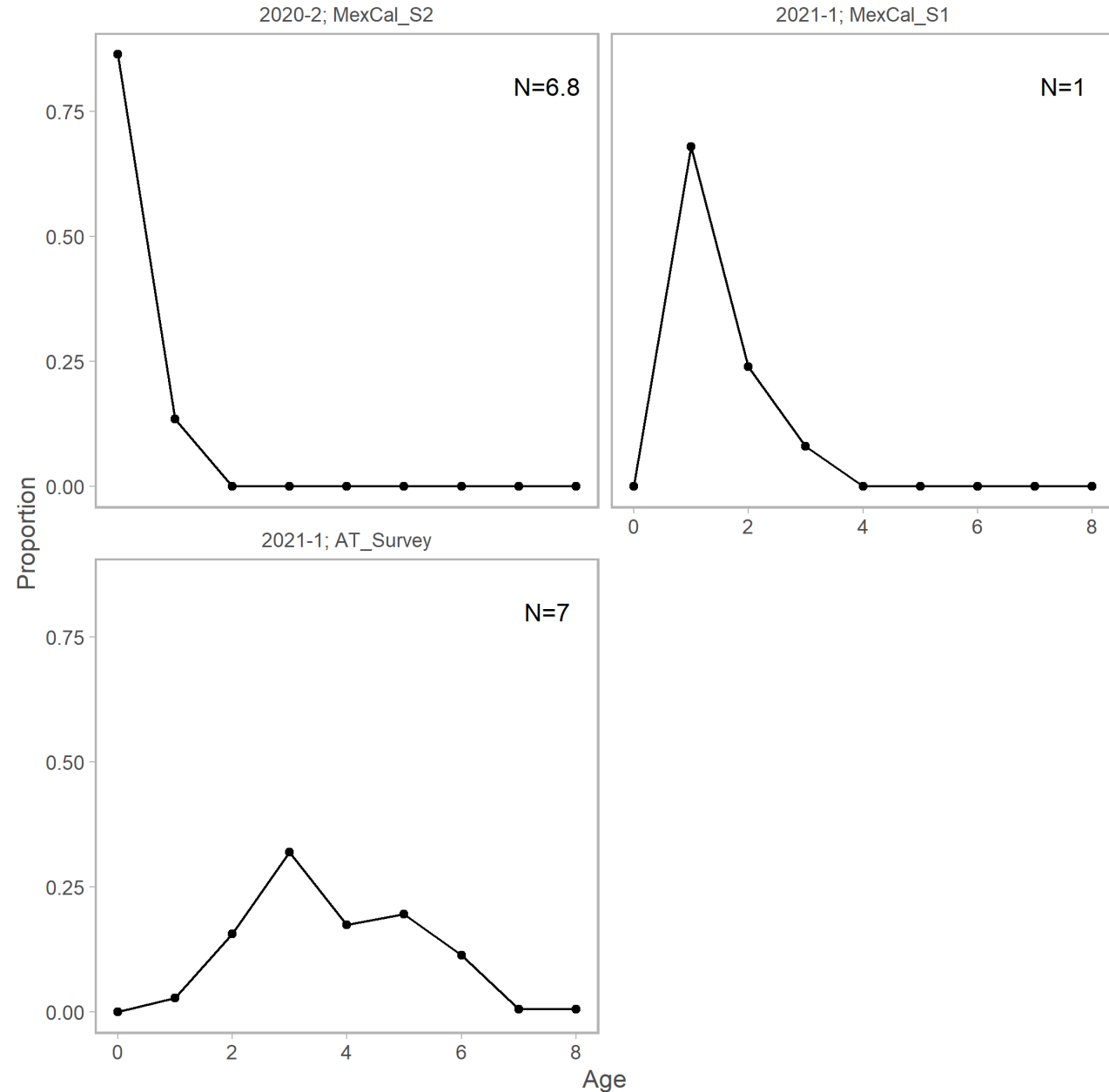
Fleet-specific landings

Calendar Y-S	Model Y-S	MexCal_S1	MexCal_S1	MexCal_S2	MexCal_S2	PNW	PNW
2019-2	2019-1	223.61	223.61	0	0	8.20	8.198
2020-1	2019-2	0	0	33,070.23	33,070.23	0.06	0.06
2020-2	2020-1	764.00	542.27	0	0	0.42	0.42
2021-1	2020-2	--	0	--	48,312.25	--	2.93
2021-2	2021-1	--	92.84	--	0	--	11.22
2022-1	2021-2	--	0	--	48,312.25	--	2.93

- Updated values in bold
- For MexCal_S2 2021-2, catch assumed to be same as previous value

New age compositions

- Fishery sample sizes are 25 fish
- Survey sample size is number of positive clusters



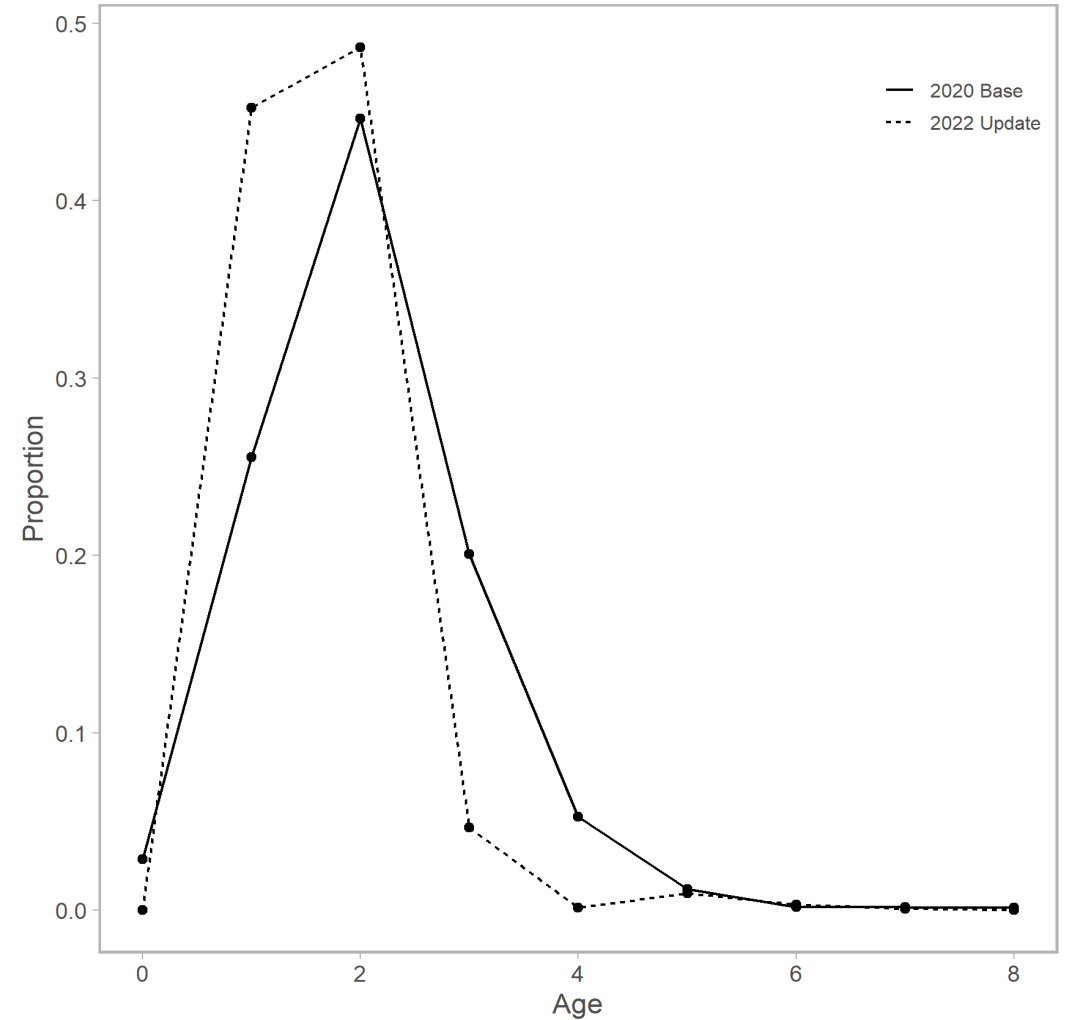
Acoustic-trawl survey

Model Yr-Sem	Acoustic						Aerial	Q ratio	LnQ ratio
	Core	CV	Nearshore	CV	Nearshore Type	Total			
2019-1	33,138	0.19	494	0.28	F/V	33,632	12,279	0.733	-0.311
2019-2	-	-	-	-	-	-	-		
2020-1	-	-	-	-	-	-	8,688		
2020-2	1,409	0.40	24,960	0.29	F/V	26,369	18,409	0.589	-0.530
2021-1	40,528	0.37	455	0.79	F/V	40,983	14,942	0.733	-0.311

- Most of 2020-2 AT survey from nearshore
- Qs adjusted based on ratio
- $\text{Total AT value} / (\text{Total AT value} + \text{aerial value})$

Re-aged otoliths

- Summer 2016 (2016-2) AT survey



2016 Revised AT Survey Age Readings

➤ Rationale

- In the 2020 Stock Assessment Model
 - Age composition for the 2016 AT biomass did not represent well patterns of recruitment and year-class strengths observed in previous years
- 2016 age readings in the model were produced by only reader-12, and there were not enough double readings to evaluate the quality of these readings

2016 Revised AT Survey Age Readings

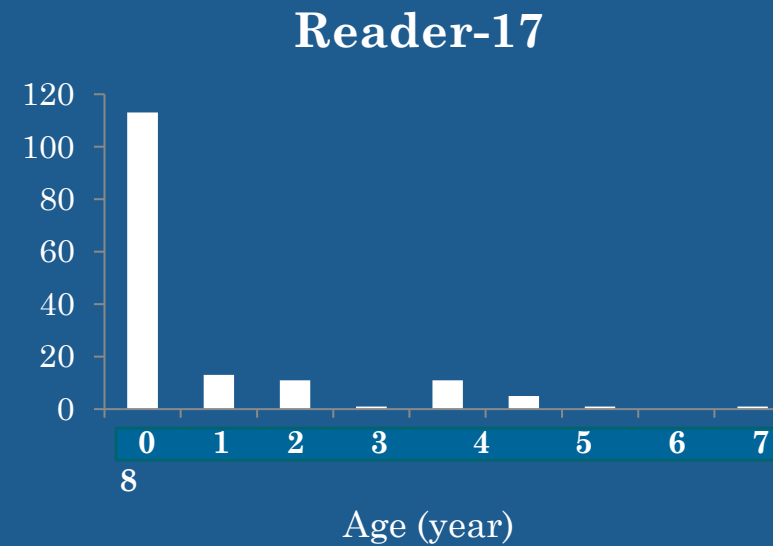
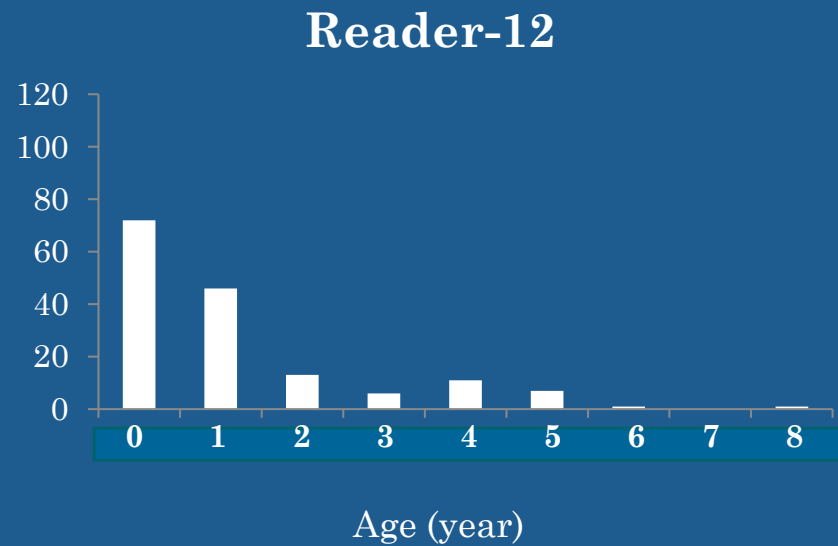
➤ Rationale

- Based on the assessment team request, in 2021 the SWFSC/CDFW conducted:
 - Double age readings of 274 otoliths previously aged by reader-12 from the 2016 Spring and Summer Survey;
 - Comparisons between reader-12 and reader-17 final readings.

2016 Revised AT Survey Age Readings

➤ Rationale

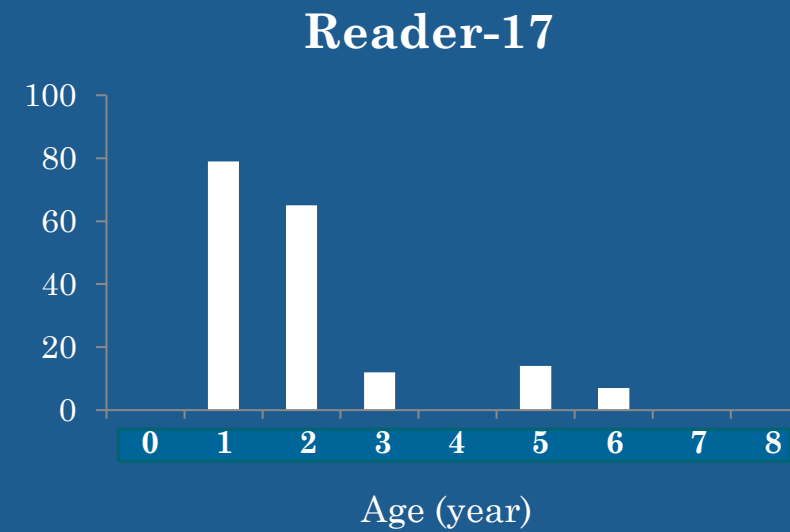
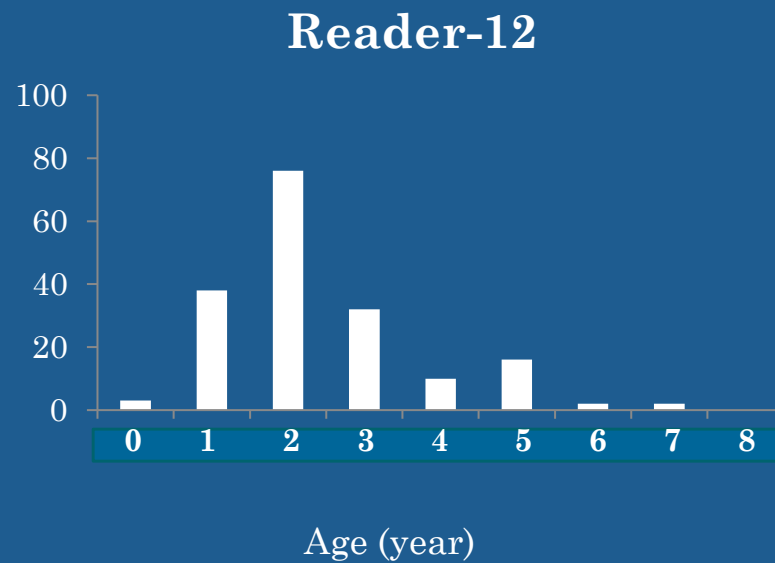
- Comparison of the spring 2016 double age readings



2016 Revised AT Survey Age Readings

➤ Rationale

- Comparison of Summer 2016 double age readings

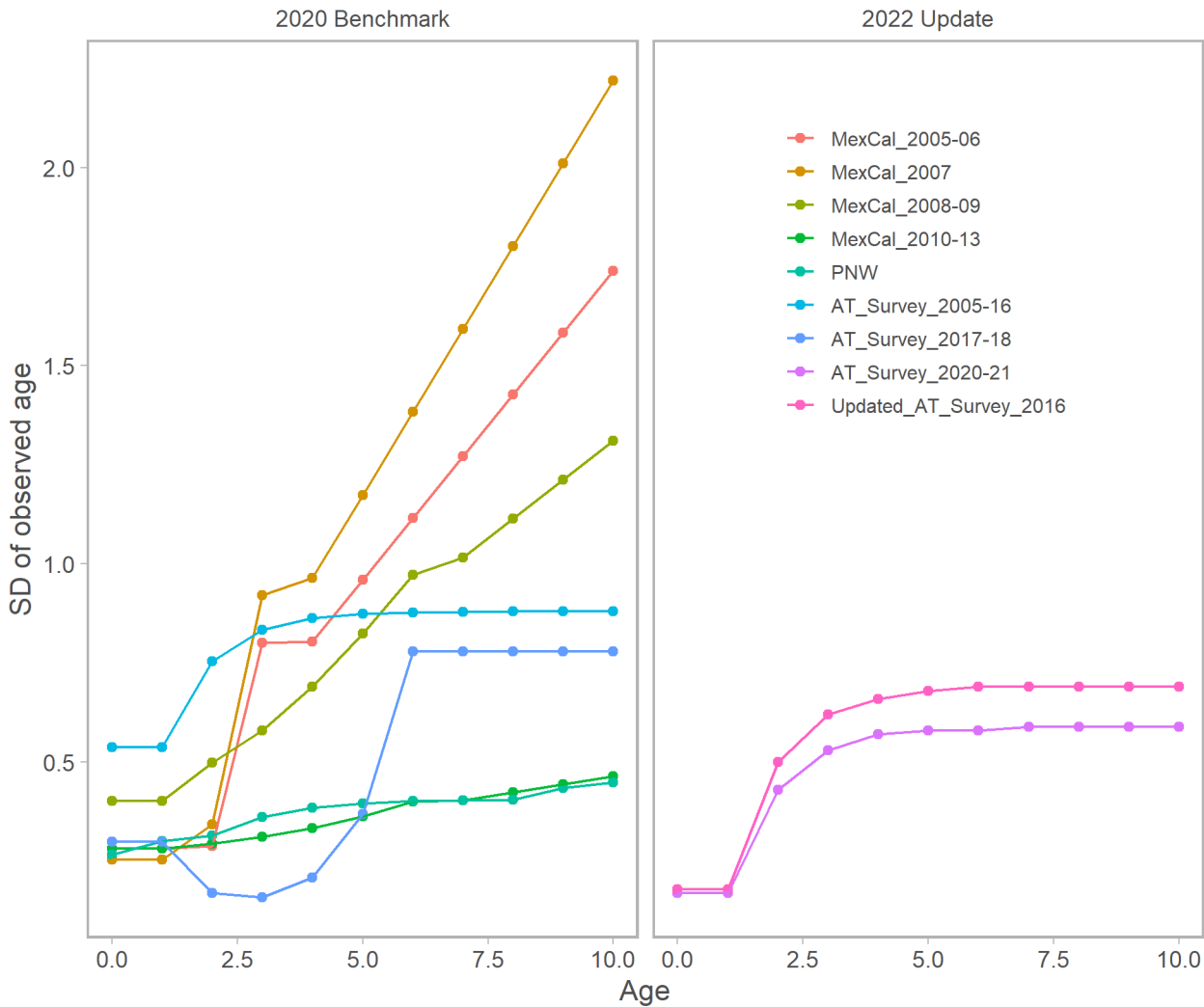


2016 Revised AT Survey Age Readings

➤ Rationale

- Based on these comparisons, it was recommended that only age readings from reader-17 be used in the 2022 update assessment
- A total of 464 revised ages from spring and summer 2016 were then submitted to the assessment team for use in 2022 and in any future stock assessment models

Ageing Error



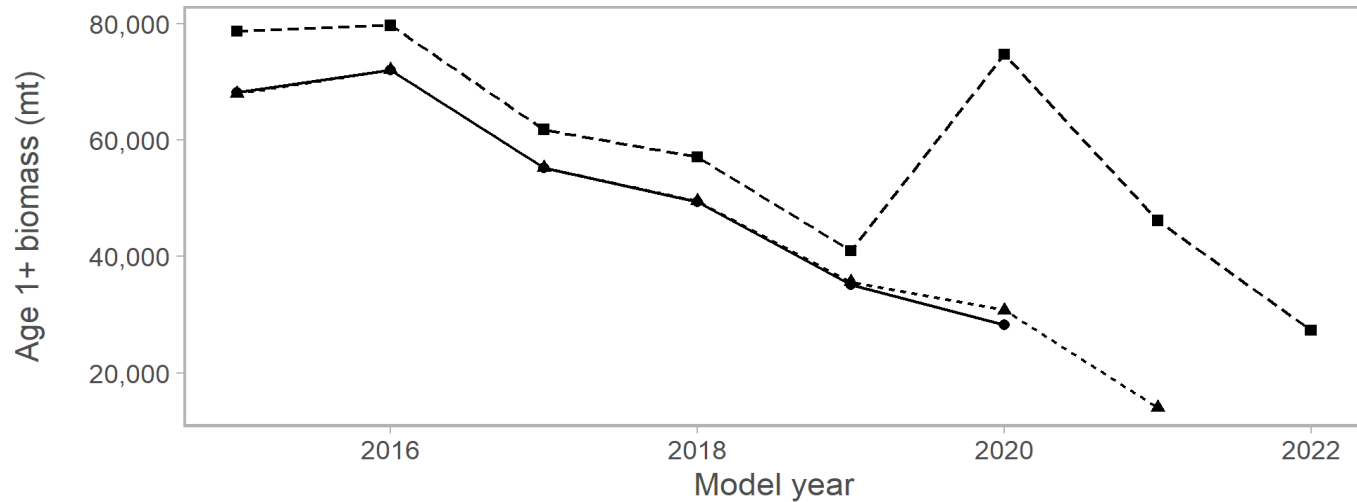
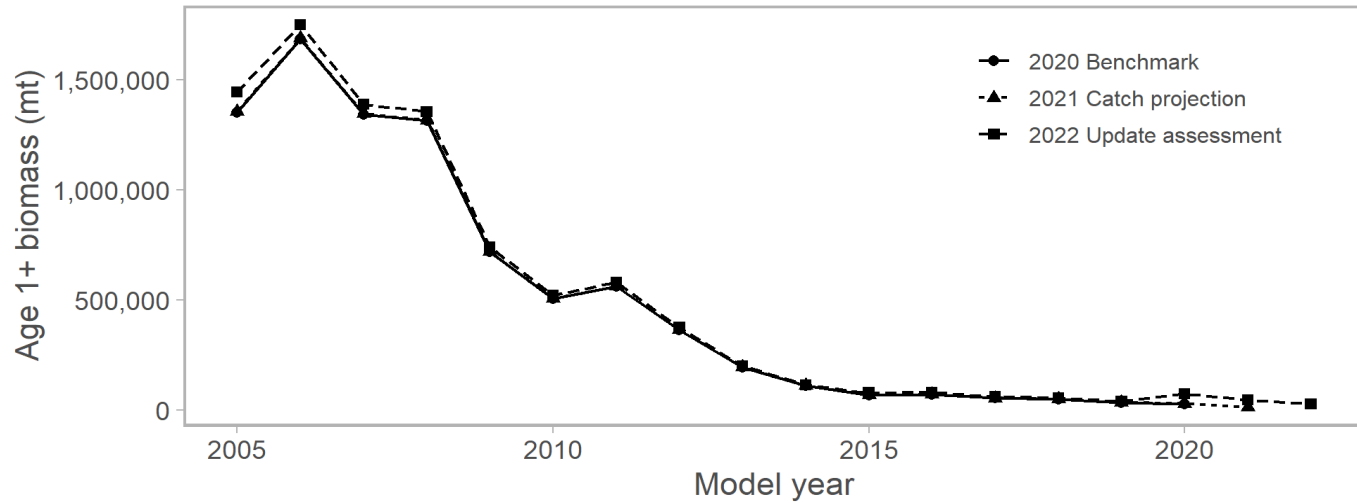
- AT Survey 2020-21 applies to new age comps
- Updated_AT_Survey_2016 applies only to re-aged otoliths

Forecast F values

Calendar Y-S	Model Y-S	MexCal_S1		MexCal_S2		PNW	
		Catch	F (yr ⁻¹)	Catch	F (yr ⁻¹)	Catch	F (yr ⁻¹)
2020-2	2021-1	92.84	0.02	0	0	1.22	0.00
2021-1	2021-2	0	0	48,312	4	2.93	0.00

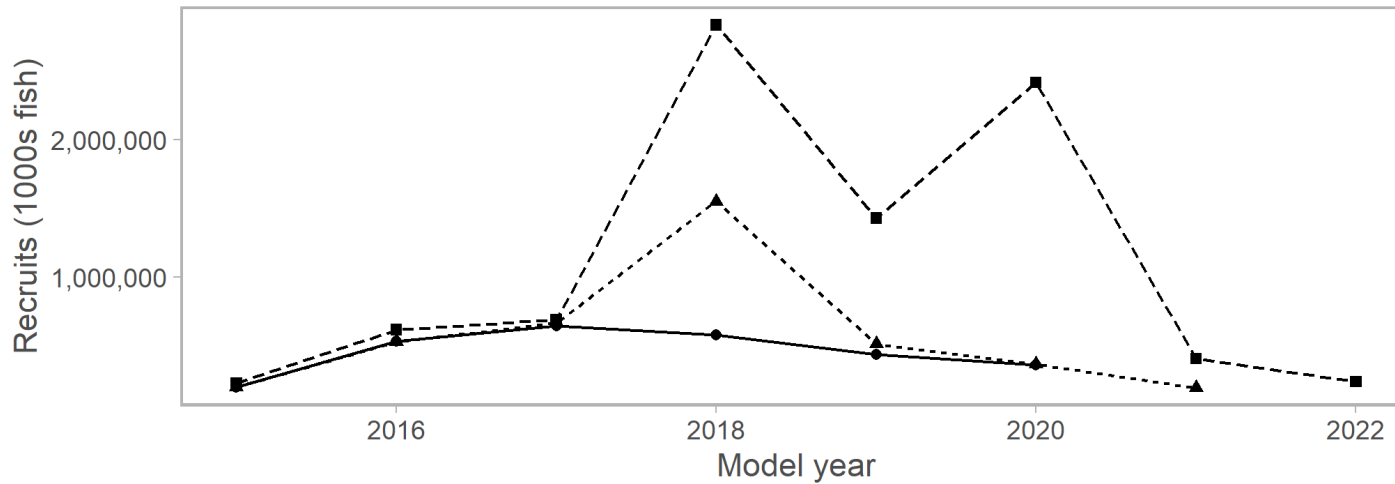
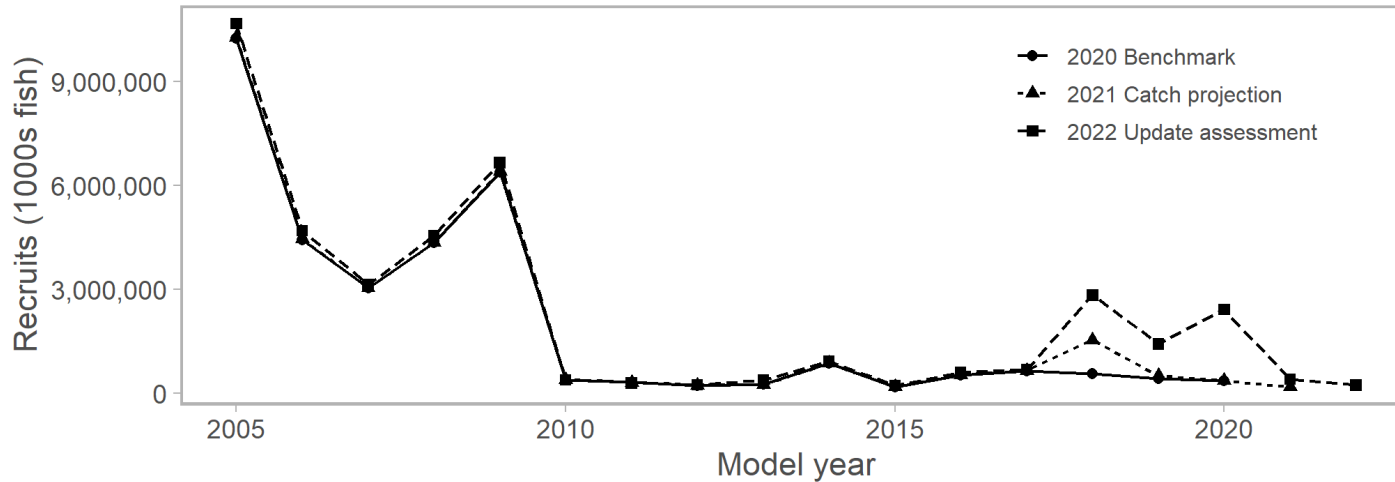
- Run model with catch values
- Use estimated F in the forecast file

Summary biomass results



- Forecast summary biomass (age 1+)=27,331 mt
- Top panel 2005-20
- Bottom panel 2015-20

Recruitment results



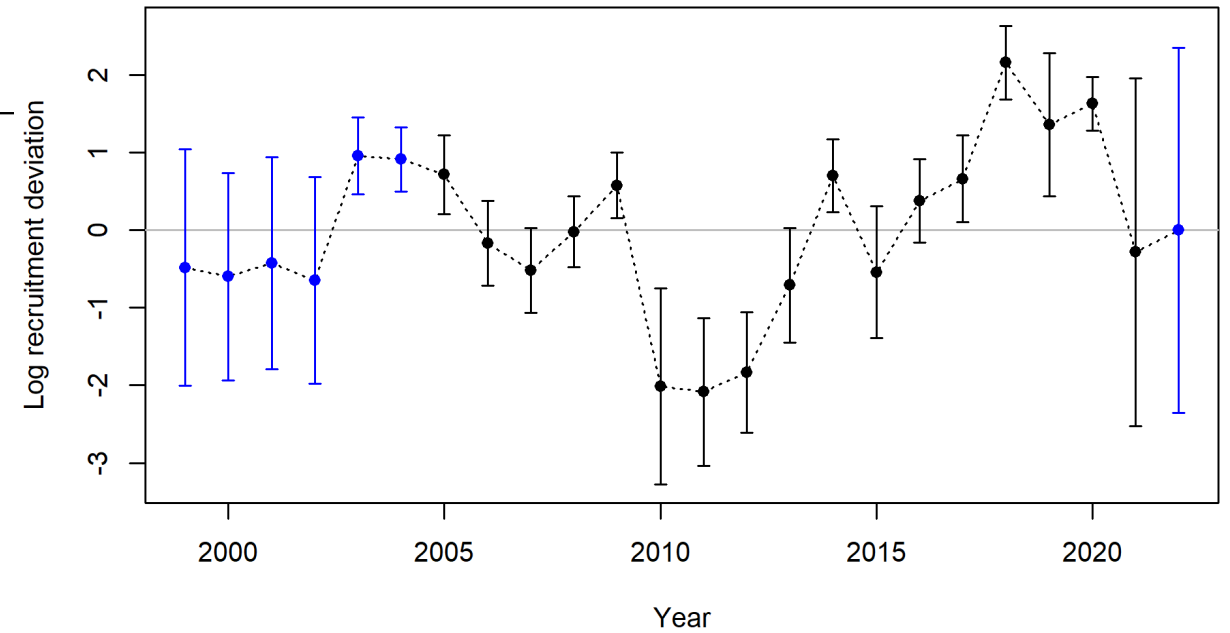
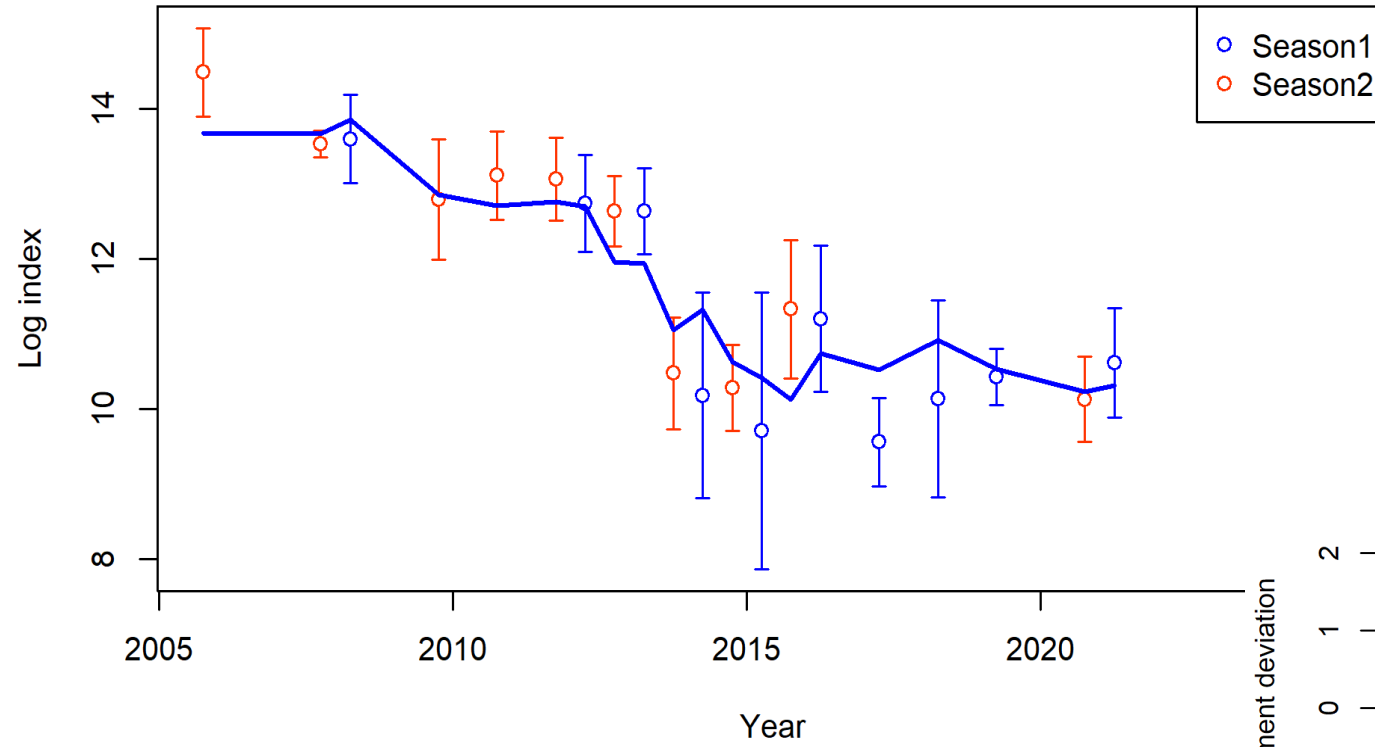
- Forecast recruitment=240 million age-0 fish
- Top panel 2005-20
- Bottom panel 2015-20

Recruitment results

- Recruitment estimates higher than in 2021
- Updated catch (high) and updated survey observations (relatively low)

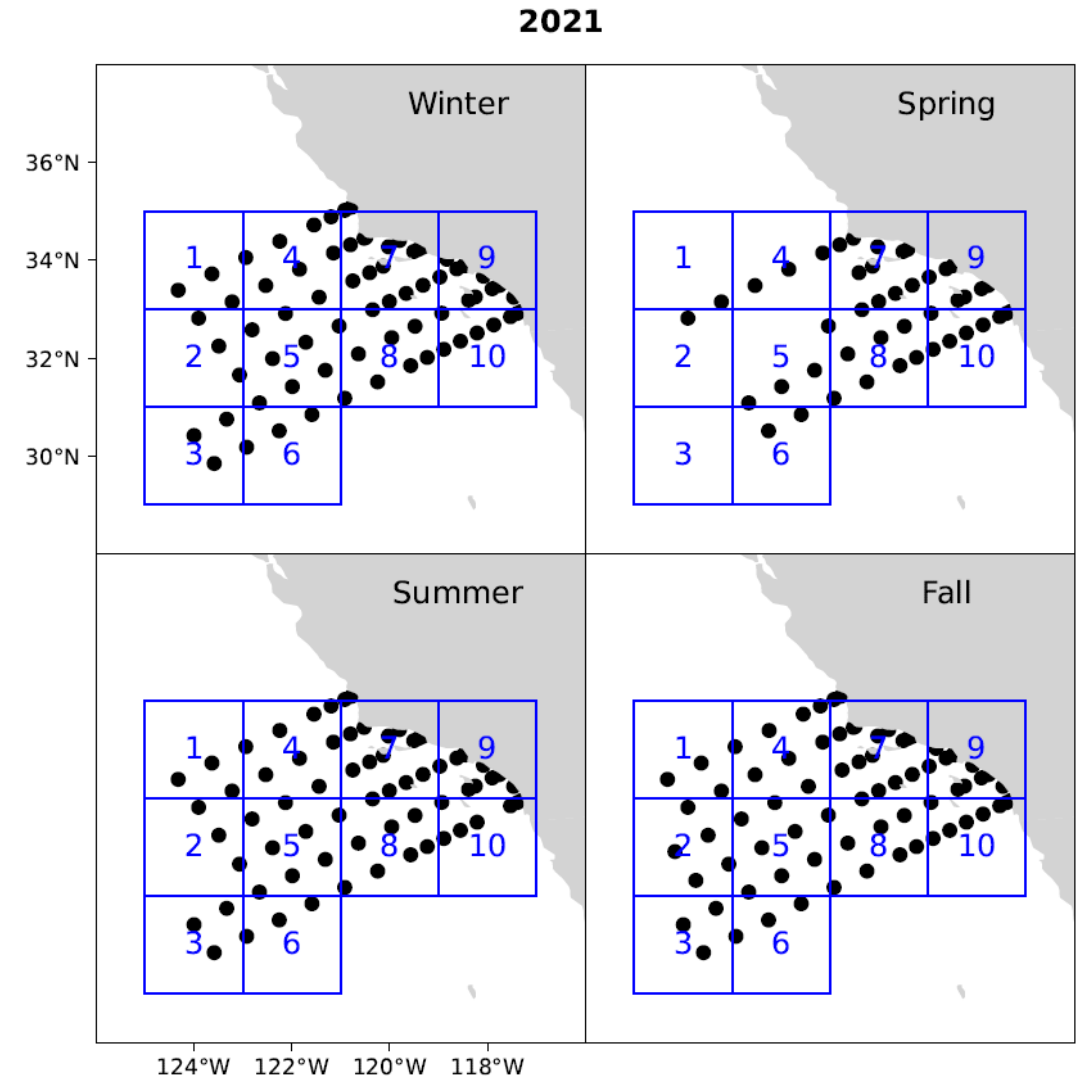
Model Y-S	2020bench	2021proj	2022update
2018-1	62,012	62,516	70,561
2018-2	44,264	44,793	49,451
2019-1	60,689	103,697	165,383
2019-2	38,008	64,179	101,657
2020-1	47,548	53,428	137,450
2020-2	29,698	32,017	81,220
2021-1	NA	30,196	176,006
2021-2	NA	18,626	82,994
2022-1	NA	NA	49,184
2022-2	NA	NA	21,669

Model Fits



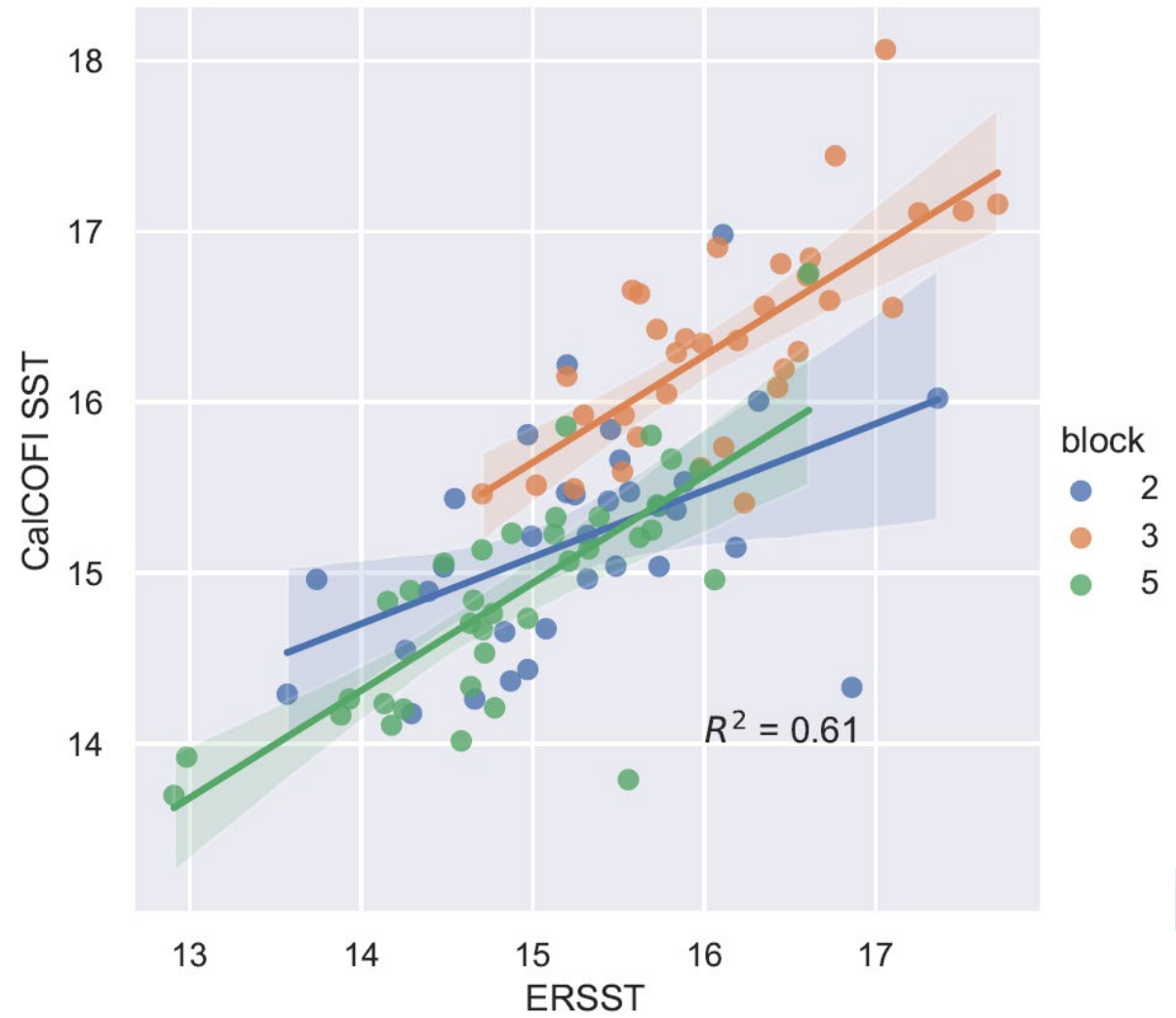
CalCOFI SST (thanks to Ed Weber)

- Dependent on spring CalCOFI SST
- Standard procedure; temperature is 15.73 °C
- Spring CalCOFI had less spatial coverage than normal



CalCOFI SST (thanks to Ed Weber)

- Reconstruction with Extended Reconstructed Sea Surface Temperature (ERSST) is 15.71 °C
- Compared to 15.73 °C
- Global monthly sea surface temperature data
- Linear regression between ERSST and CalCOFI
- Done with canceled cruises; no approved method for cruises with low spatial coverage

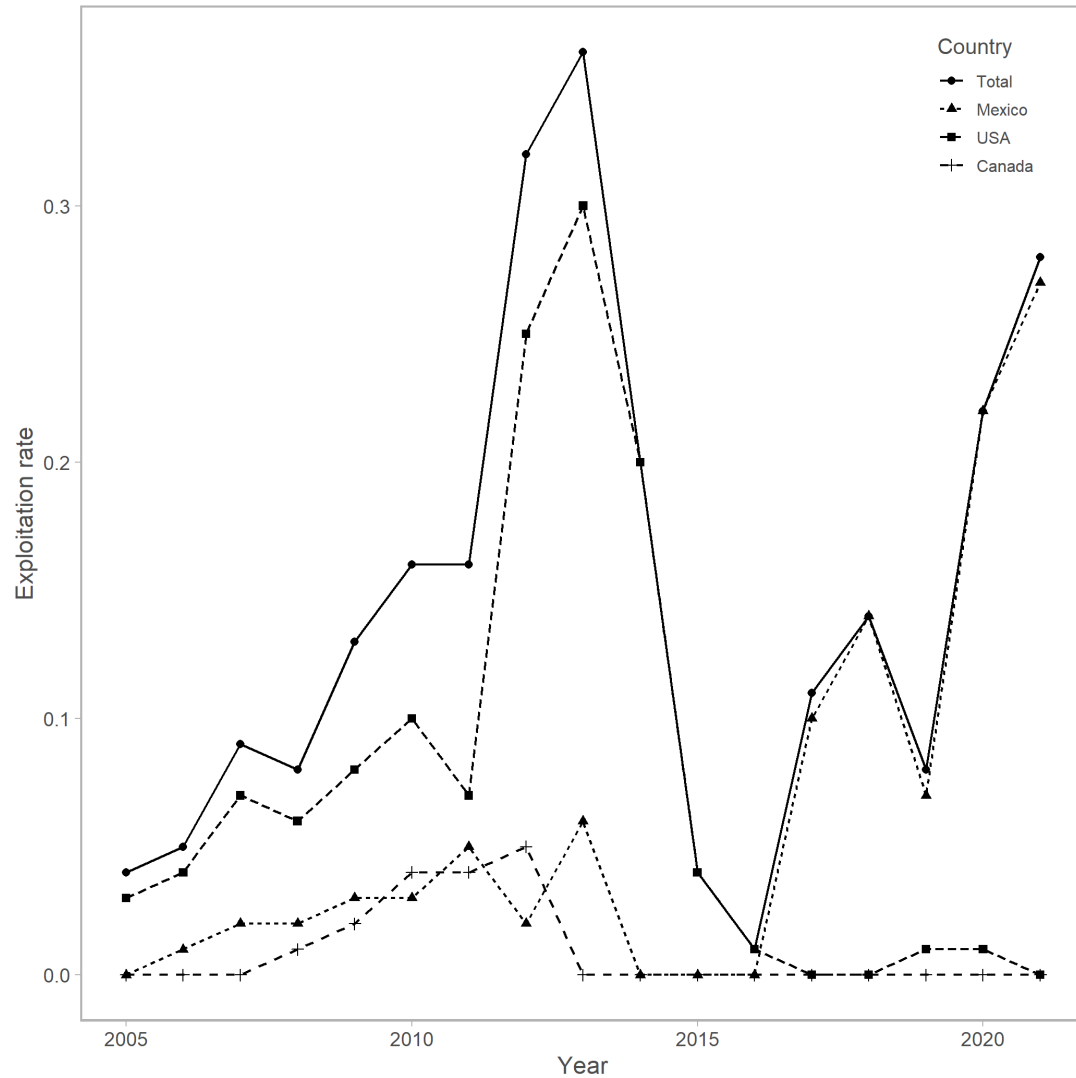


Harvest Guidelines

- E_{MSY} and ABC values will be available later
- Italicized and greyed out values subject to change

Harvest Control Rule Formulas										
OFL = BIOMASS * E_{MSY} * DISTRIBUTION; where E_{MSY} is bounded 0.00 to 0.25										
ABC _{P-star} = BIOMASS * BUFFER _{P-star} * E_{MSY} * DISTRIBUTION; where E_{MSY} is bounded 0.00 to 0.25										
HG = (BIOMASS - CUTOFF) * FRACTION * DISTRIBUTION; where FRACTION is E_{MSY} bounded 0.05 to 0.20										
Harvest Formula Parameters										
BIOMASS (ages 1+, mt)	27,331									
P-star	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	
ABC Buffer _(Sigma 0.5)	<i>0.93910</i>	<i>0.88102</i>	<i>0.82476</i>	<i>0.76936</i>	<i>0.71373</i>	<i>0.65651</i>	<i>0.59558</i>	<i>0.52688</i>	<i>0.43936</i>	
ABC Buffer _{Tier 2}	<i>0.88191</i>	<i>0.77620</i>	<i>0.68023</i>	<i>0.59191</i>	<i>0.50942</i>	<i>0.43101</i>	<i>0.35472</i>	<i>0.27761</i>	<i>0.19304</i>	
ABC Buffer _{Tier 3}	<i>0.77777</i>	<i>0.60248</i>	<i>0.46272</i>	<i>0.35036</i>	<i>0.25950</i>	<i>0.18577</i>	<i>0.12582</i>	<i>0.07707</i>	<i>0.03726</i>	
CalCOFI SST (2018-2020)	<i>16.0140</i>									
EMSY	<i>0.239680</i>									
FRACTION	<i>0.239680</i>									
CUTOFF (mt)	150,000									
DISTRIBUTION (U.S.)	0.87									
Harvest Control Rule Values (MT)										
OFL =	5,699									
ABC(Sigma 0.607) =	<i>5,352</i>	<i>5,021</i>	<i>4,700</i>	<i>4,385</i>	<i>4,068</i>	<i>3,742</i>	<i>3,394</i>	<i>3,003</i>	<i>2,504</i>	
ABCTier 2 =	<i>5,026</i>	<i>4,424</i>	<i>3,877</i>	<i>3,373</i>	<i>2,903</i>	<i>2,456</i>	<i>2,022</i>	<i>1,582</i>	<i>1,100</i>	
ABCTier 3 =	<i>4,433</i>	<i>3,434</i>	<i>2,637</i>	<i>1,997</i>	<i>1,479</i>	<i>1,059</i>	<i>717</i>	<i>439</i>	<i>212</i>	
HG =	0									

Recent harvests



Fishing-year	USA ACL	USA ACT	USA Landings	Mexico Landings	Canada Landings
2017-2018	8,000		372	9,736	0
2018-2019	7,000		651	11,634	0
2019-2020	4,514	4,000	705	29,555	0
2020-2021	4,288	4,000	852	48,005	0
2021-2022	3,000	3,000	105	0*	0

Uncertainties

- High catches from Mexico
- Uncertainties associated with low biomass levels