Using Fishery independent and dependent indices for apportionment estimation of BSAI Atka Mackerel

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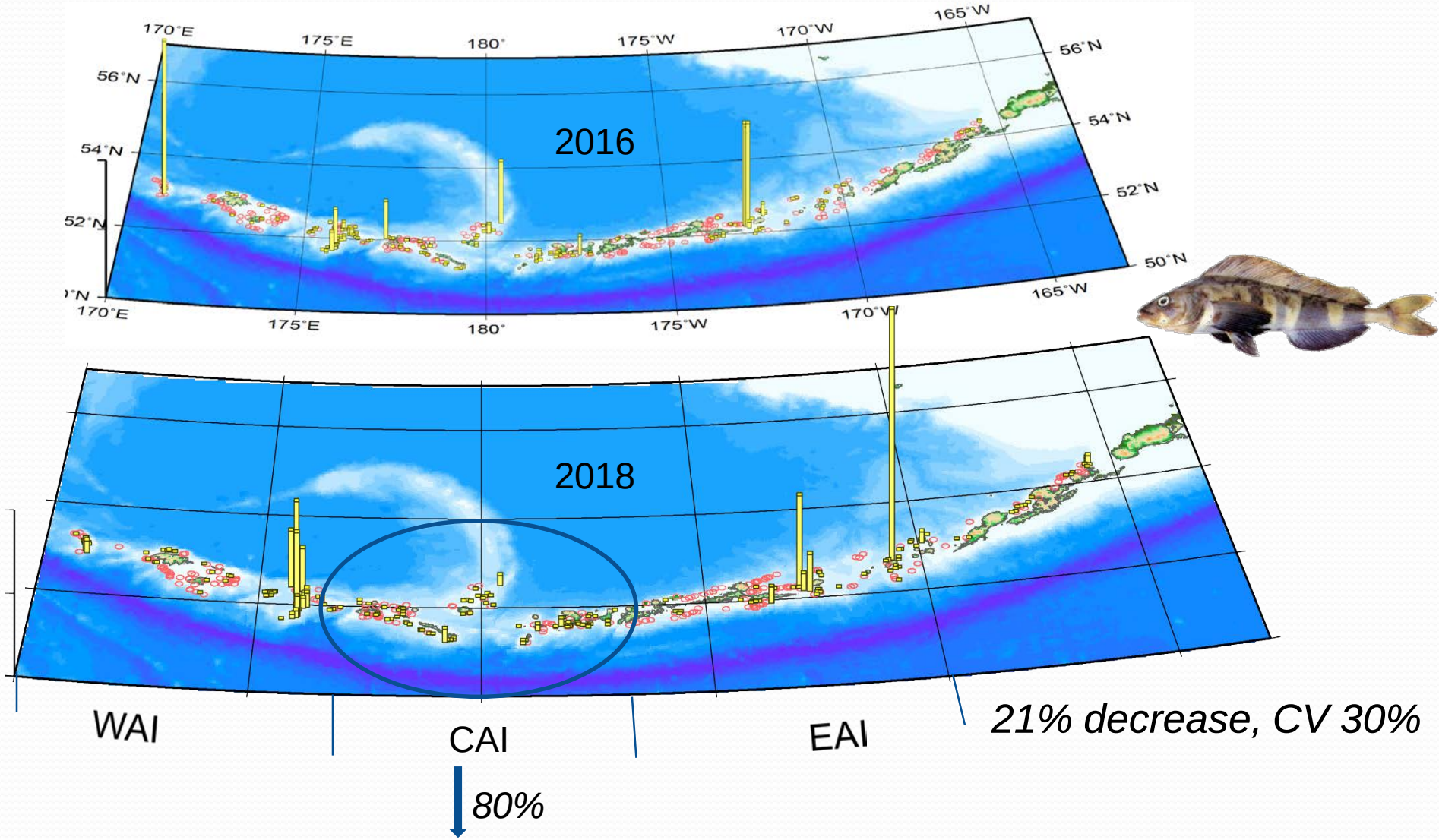
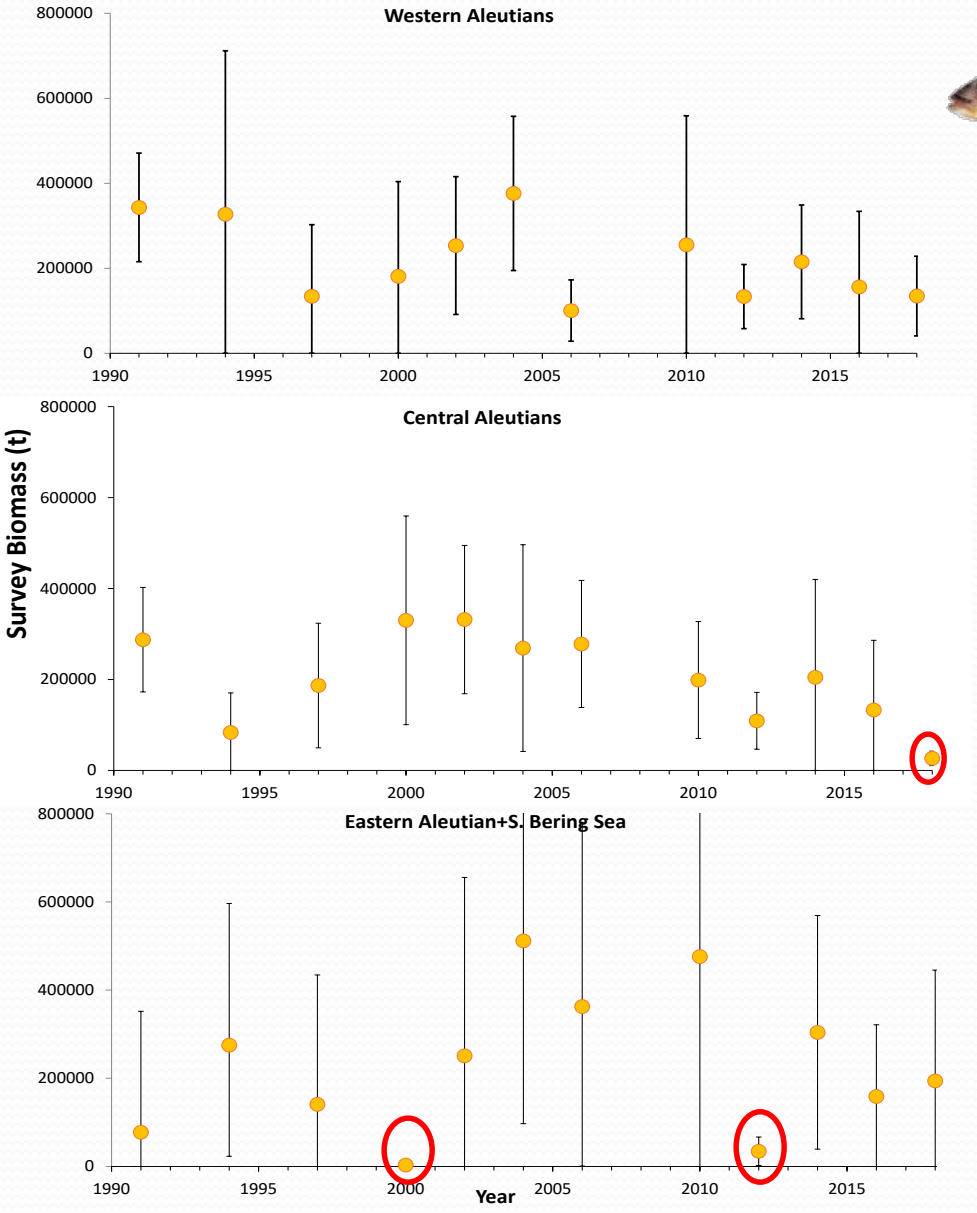
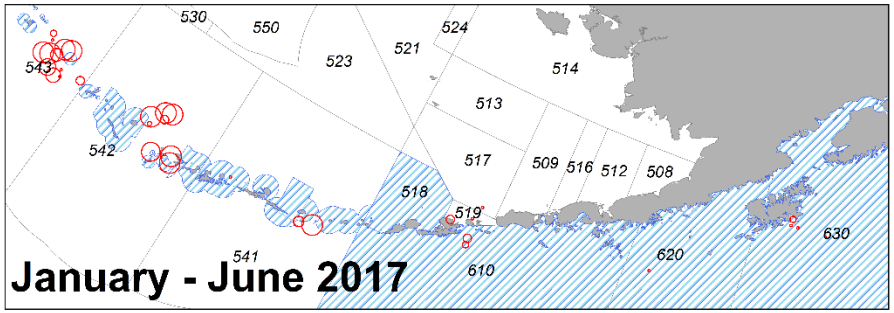
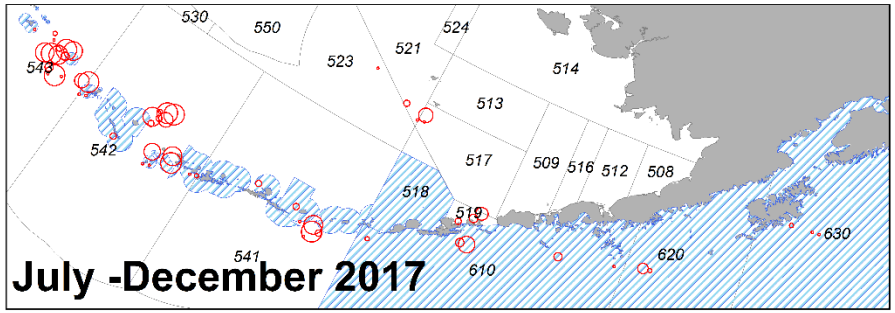
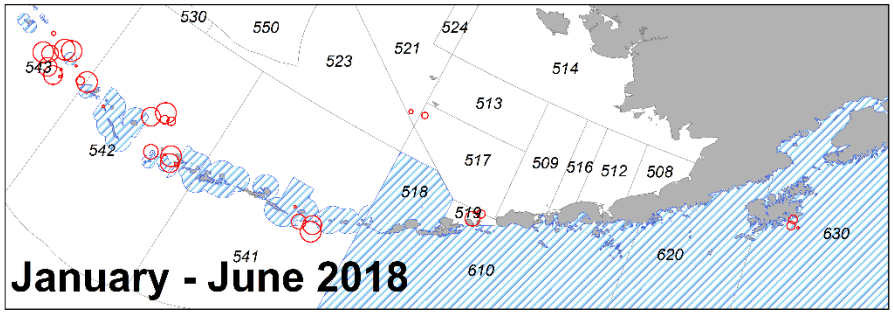
Bottom trawl survey CPUE distributions of Atka mackerel catches

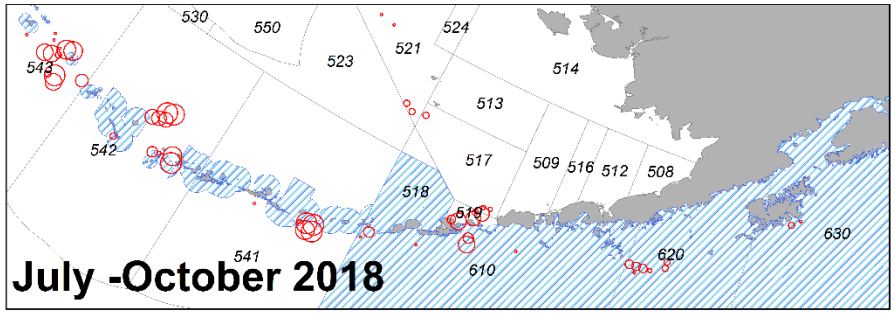



Western Aleutians
Central Aleutians
Eastern Aleutian+S. Bering Sea
Survey Biomass (t)
Year
800000
600000
400000
200000
0
1990
1995
2000
2005
2010
2015









Observed catch (Tons)

- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 40
- 41 - 80
- 81 - 100
- 101 - 200
- 201 - 400
- 401 - 800
- > 800

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- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 40
- 41 - 80
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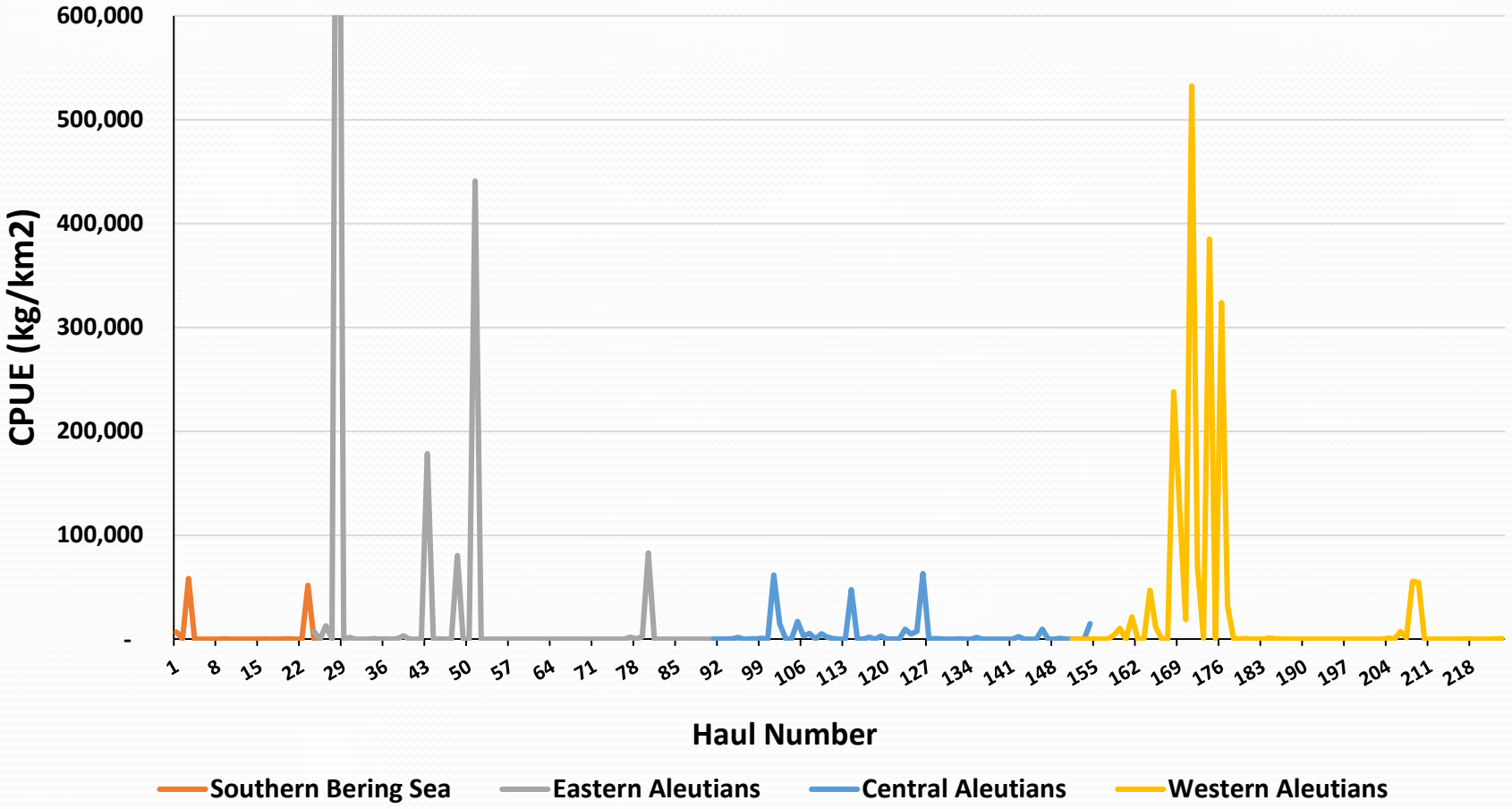
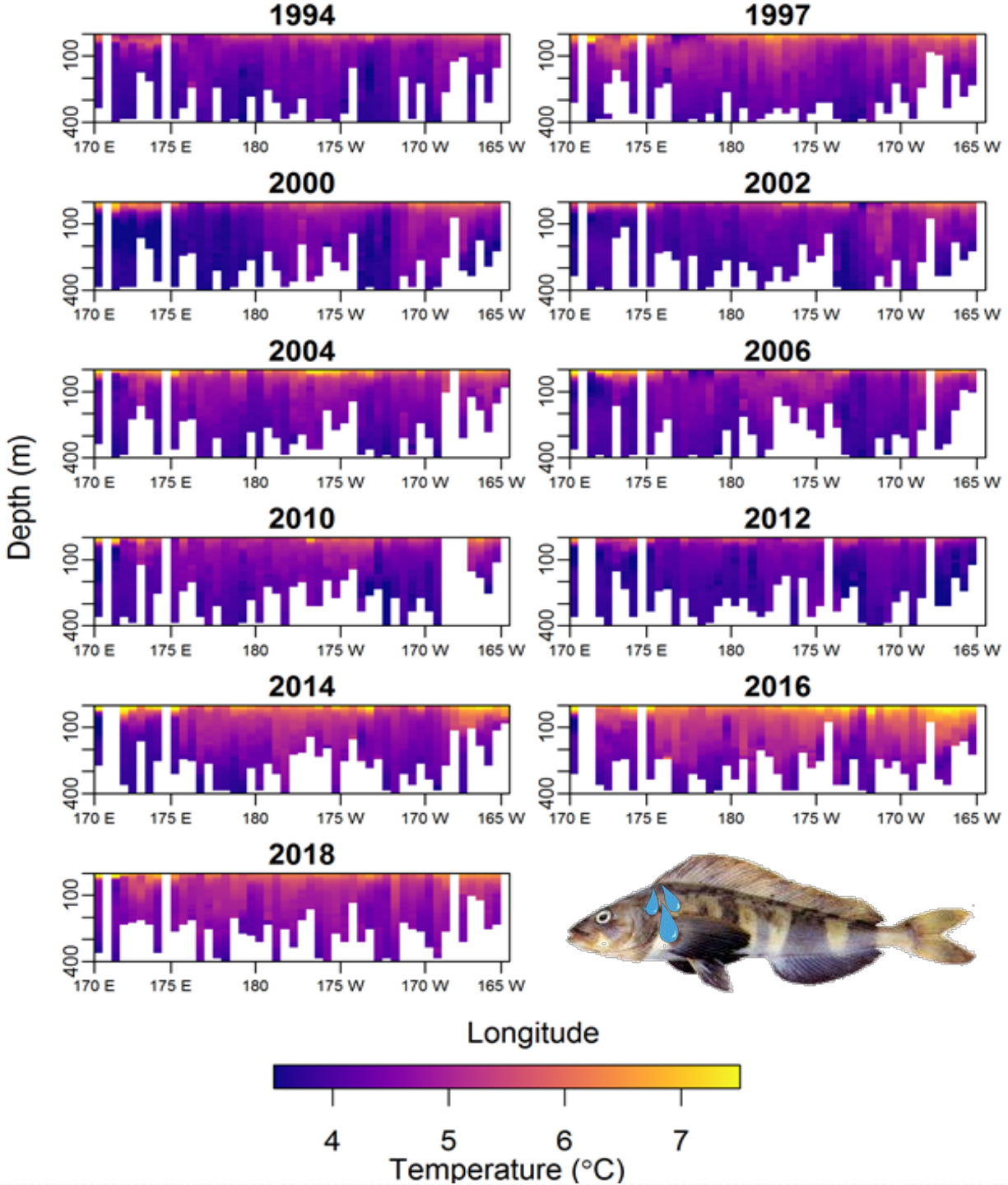
2017-2018

Atka mackerel fishery locations

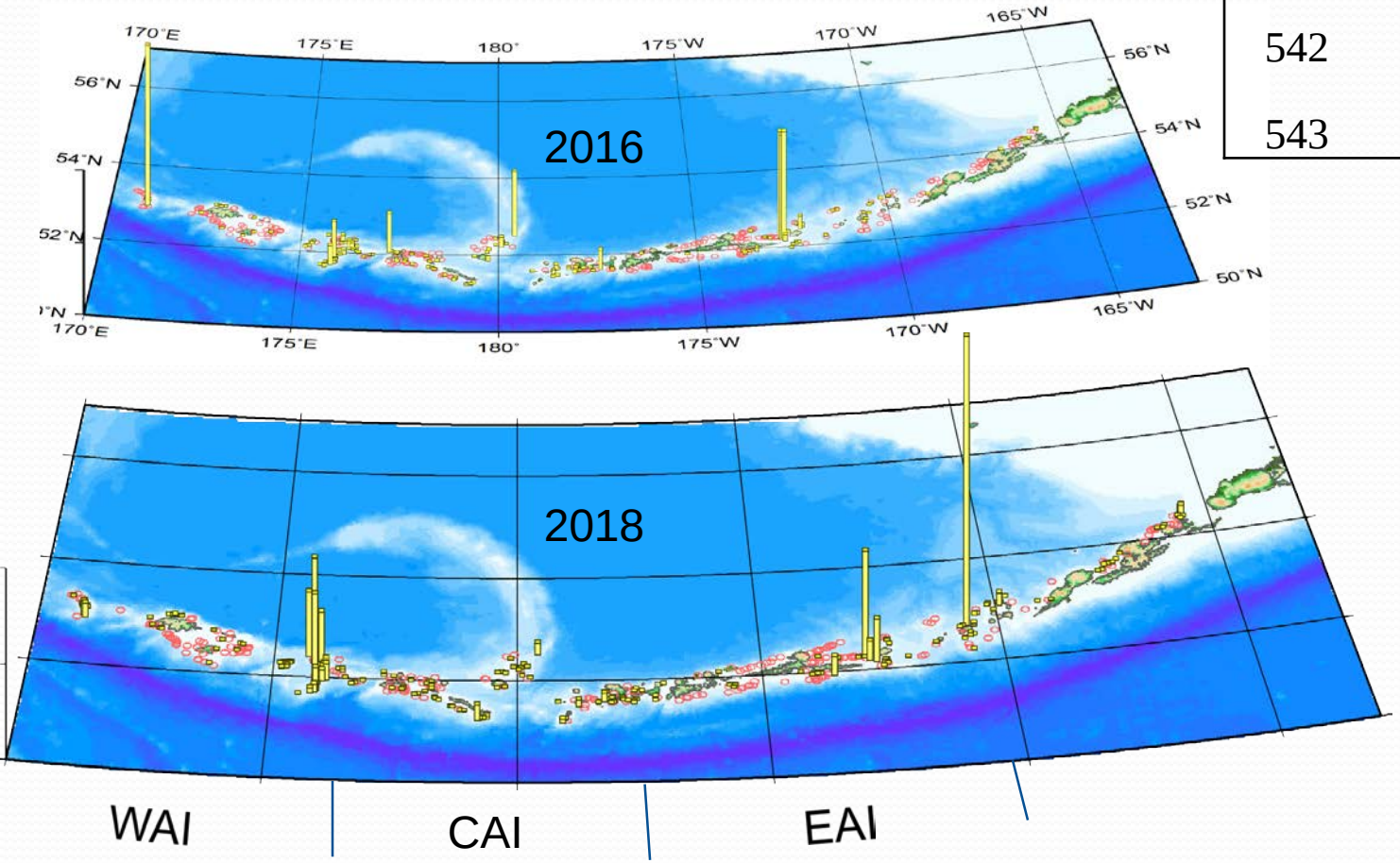
2018 Aleutian Islands Survey Atka Mackerel CPUE (kg/km2)




1994
1997
2000
2002
2004
2006
2010
2012
2014
2016
2018
Depth (m)
100
400
170 E
175 E
180
175 W
170 W
165 W
Longitude
4
5
6
7
Temperature (°C)

BSAI Atka Mackerel Apportionment

	2017 Random Effects Model	2018 Random Effects Model
541	**40%**	**50%**
542	**35%**	**10%**
543	**25%**	**40%**



Recommended
BSAI Atka Mackerel Apportionment

Recommended ABC apportionments for 2019 and 2020 based on 4-survey weighted average

	Survey Year				2019 & 2020 Apport.
	2012	2014	2016	2018	
541+SBS	12%	42%	35%	38%	35%
542	39%	28%	30%	7%	21%
543	48%	30%	35%	55%	44%
Weights	8	12	18	27	

2018 SSC and BSAI Plan Team recommendations

1. The SSC noted: "…that having an apportionment method that is robust to large deviations in regional survey biomass estimates is critical." Specifically, they recommended:
   a. The PT recommended additional research to develop appropriate apportionment methods for this stock in the future, with an emphasis on investigating the application and validation of the autoregressive spatio-temporal modeling approach developed in the VAST modeling framework for such purposes. The SSC supports additional research into a more robust allocation method.

Present an alternative approach to the RE model for consideration following Hulson et al. (In prep.)

- Applies a common process error across regions
- Allows for multiple indices
- Hulson *et al*. (*In prep*.) used longline survey indices (SST and SR/RE)

1st step examination of NMFS observer fishery data

- Focus on 8 main vessels that fished 2008-2019
- Summarized tow duration, observed catch, and mean nominal CPUE

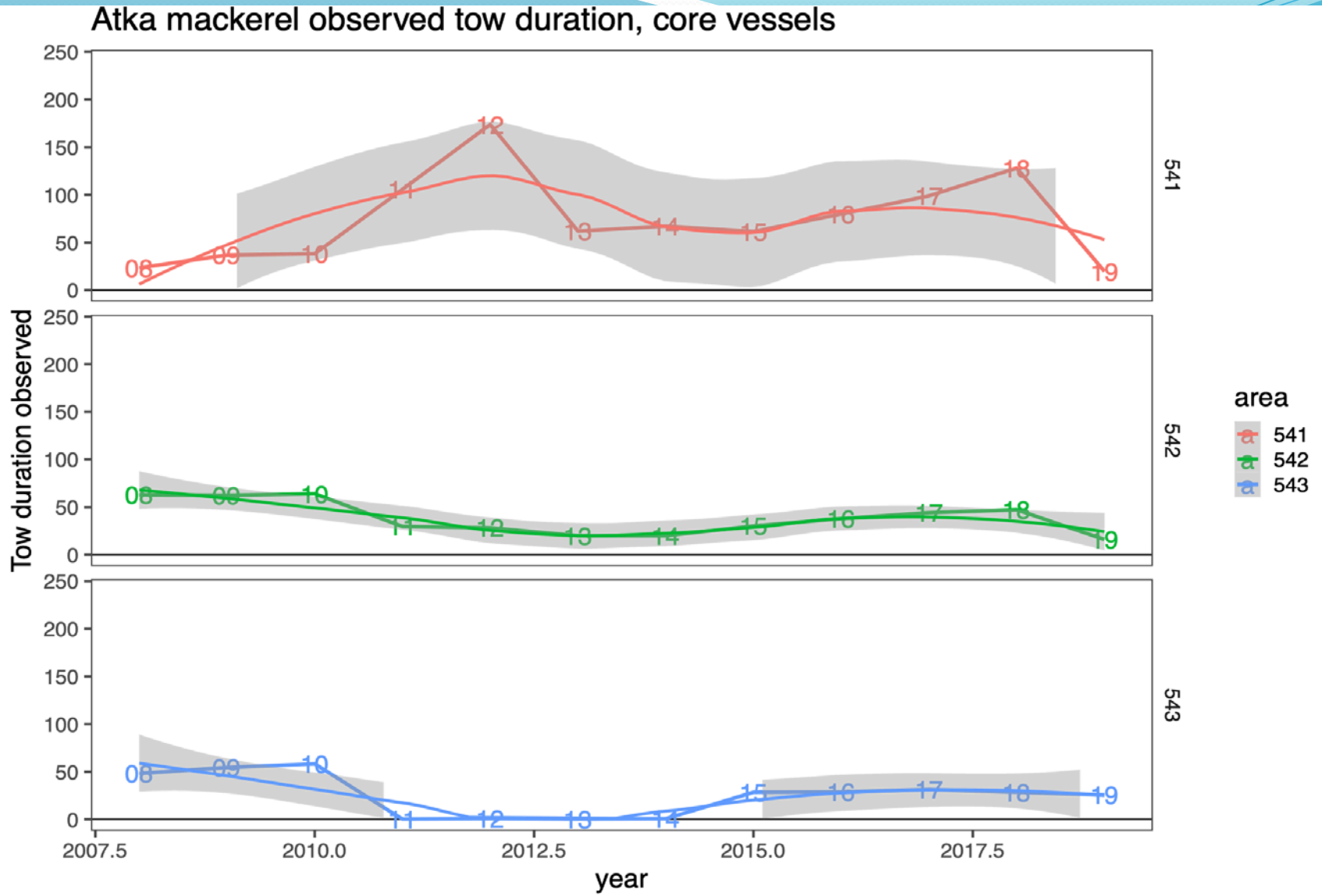


Figure 1. Annual sum of observed tow duration (hours) by Aleutian Islands management areas (541=Eastern, 542=Central, 543-Western) from the eight “core” vessels selected for analysis. Shaded regions generated by smoother through the data.

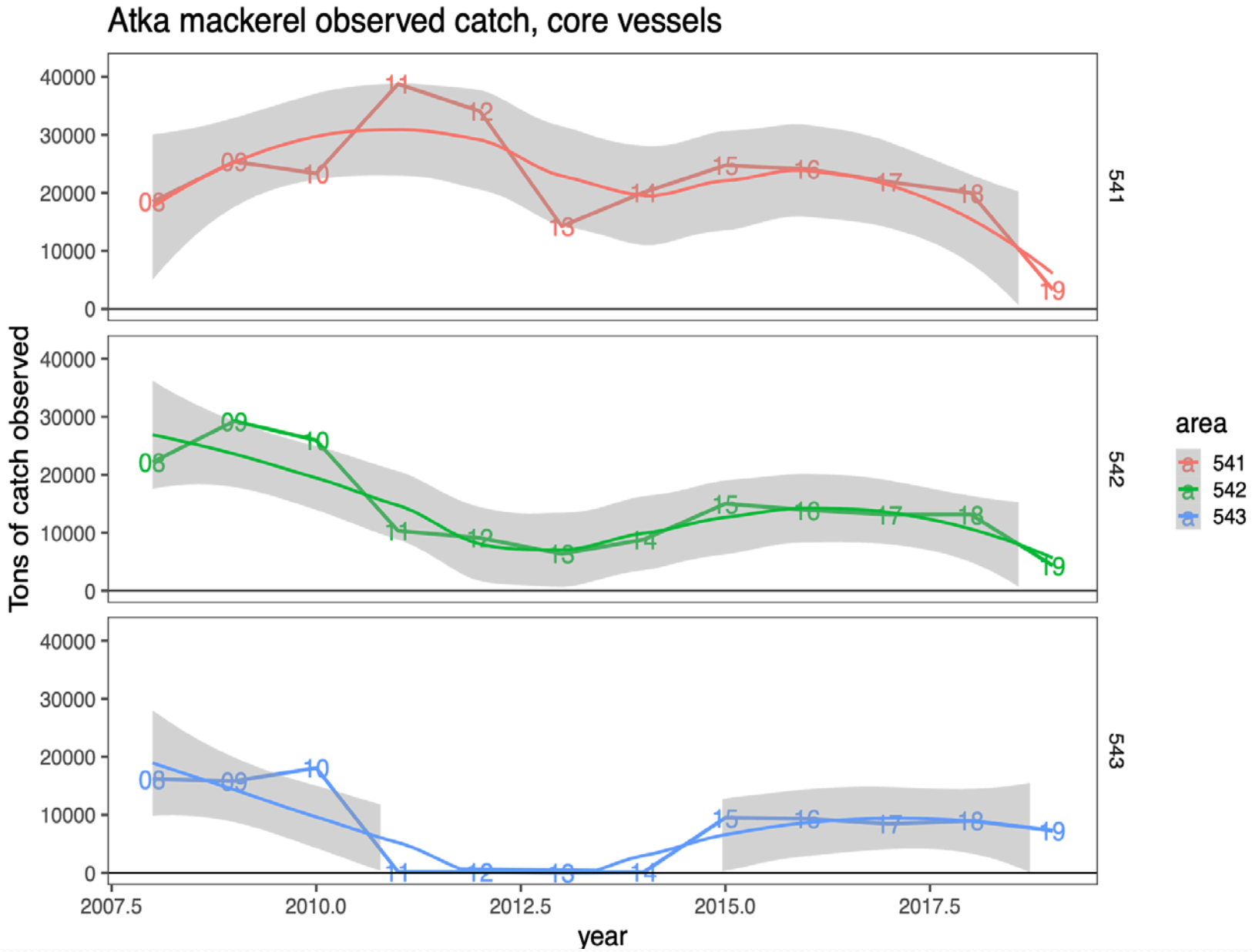


Figure 2. Annual sum of observed catch by Aleutian Islands management areas (541=Eastern, 542=Central, 543-Western) from the eight “core” vessels selected for analysis. Shaded regions generated by smoother through the data.

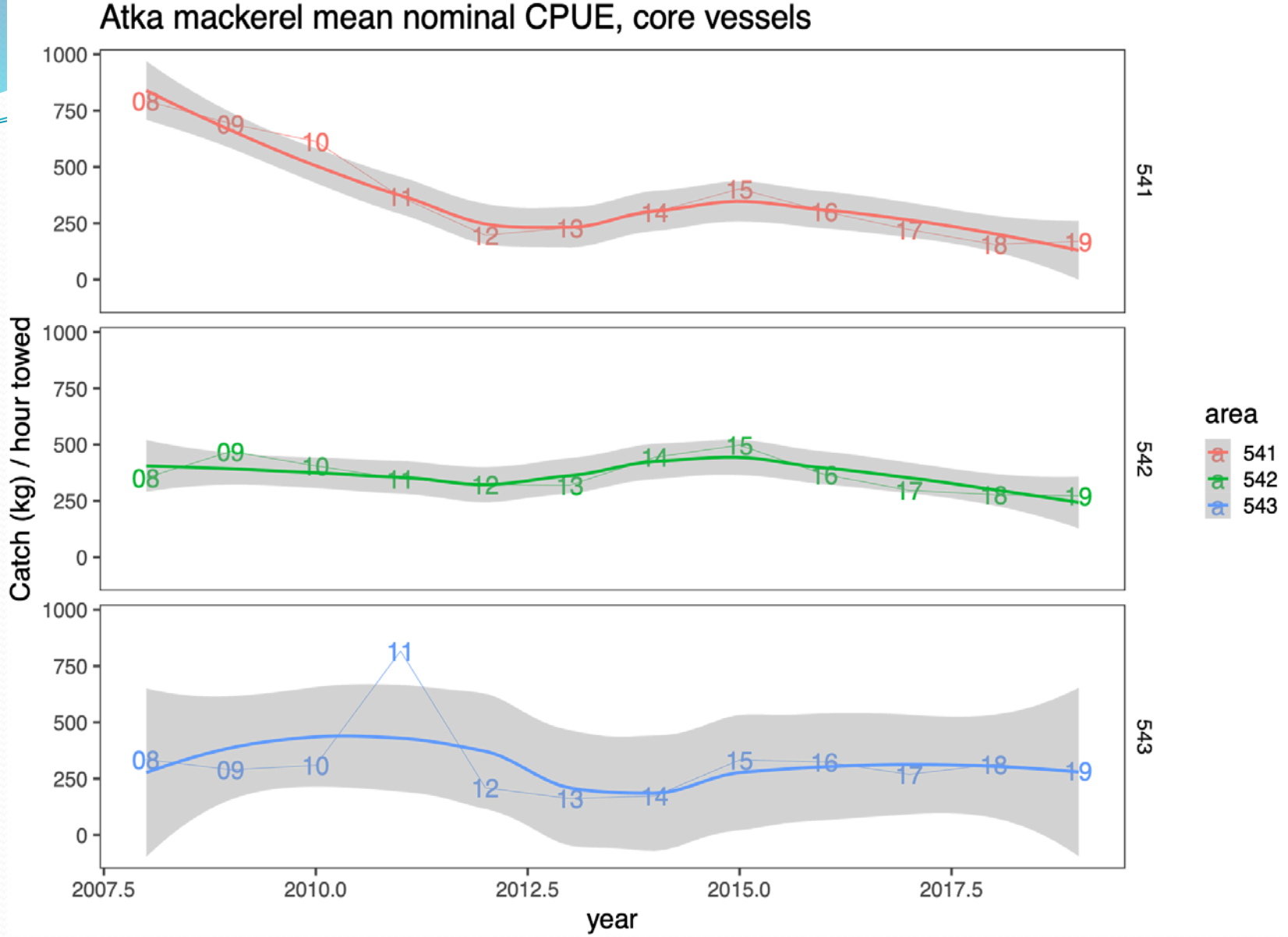
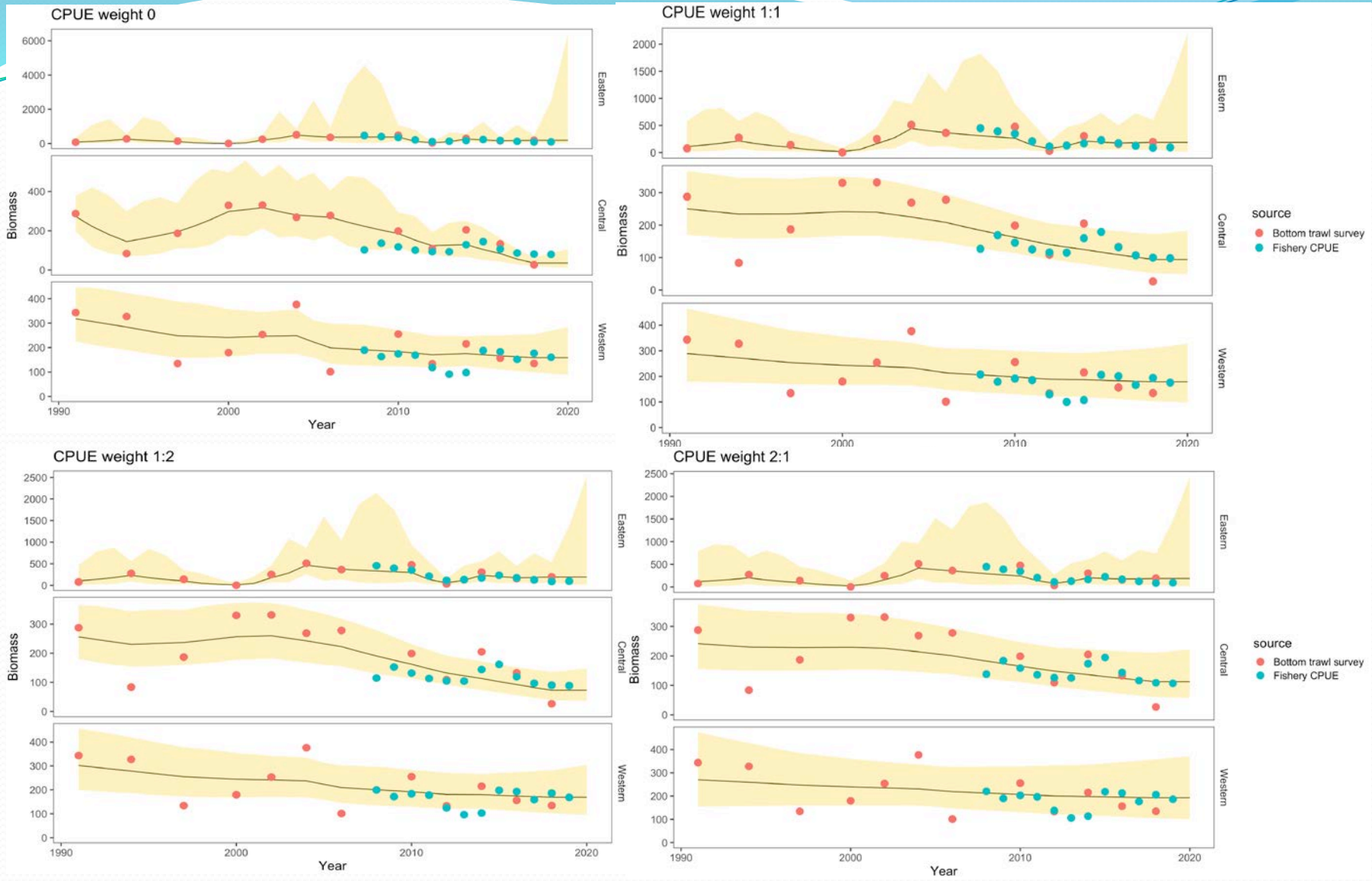


Figure 3. Mean nominal CPUE for Atka mackerel for Aleutian Islands management areas (541=Eastern, 542=Central, 543-Western) from the eight “core” vessels selected for analysis. Shaded regions generated by smoother through the data.

Implemented the RE model (Hulson et al. In prep) with varying weights applied to fishery CPUE indices:

- Zero weight on fishery CPUE (~2018 RE model)
- Half weight of the survey index
- Equal weight to the survey index
- Double the weight of survey index
- All weight on fishery CPUE data



Atka mackerel area-apportionment results fit with the random-effects model to both survey and nominal fishery CPUE data (with the western data from 2011-2014 downweighted). In this case, the weight is given to only the bottom trawl survey data for illustration purposes.

Table 1. Apportionment percentages by Aleutian Islands management areas with different weightings of fishery CPUE data.

CPUE weight	Eastern	Central	Western
0.0	49.6%	9.3%	41.1%
0.5	43.8%	17.0%	39.2%
1.0	40.8%	20.4%	38.7%
2.0	38.0%	22.8%	39.2%
100	32.7%	26.2%	41.1%

	Eastern	Central	Western
2017 RE model	40%	35%	25%
2018 RE model	50%	10%	40%
4-survey wtd avg	35%	21%	44%

CPUE weight	Eastern	Central	Western
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0.5	43.8%	17.0%	39.2%
1.0	40.8%	20.4%	38.7%
2.0	38.0%	22.8%	39.2%
100	32.7%	26.2%	41.1%

Considerations and further research

- Data unavailable on fishery search time
- Differences in fishery and survey selectivity and catchability
  - Between regions a reasonable proxy for relative abundance?
  - Atka mackerel sizes in survey similar in both
- VAST modeling framework
  - Aleutian Islands region ongoing…
- Expanded RE model
  - Incorporates multiple indices
  - Simple and flexible
  - Further explorations of region-specific data conflicts (survey vs fishery)
  - Simulation-evaluation needed for understanding risks and tradeoffs

Plan Team feedback and comments

- Reasonable approach for use for apportionment of Atka mackerel ABC?
- Choice of weighting of the indices?