

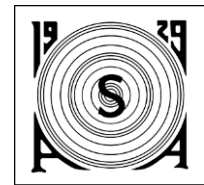
From acoustic recordings to predicting the probability of encountering odontocetes on Canada's East Coast

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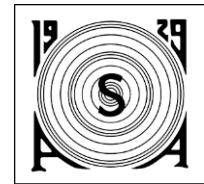
²Dalhousie University, Department of Oceanography

³Dalhousie University, Department of Biology.

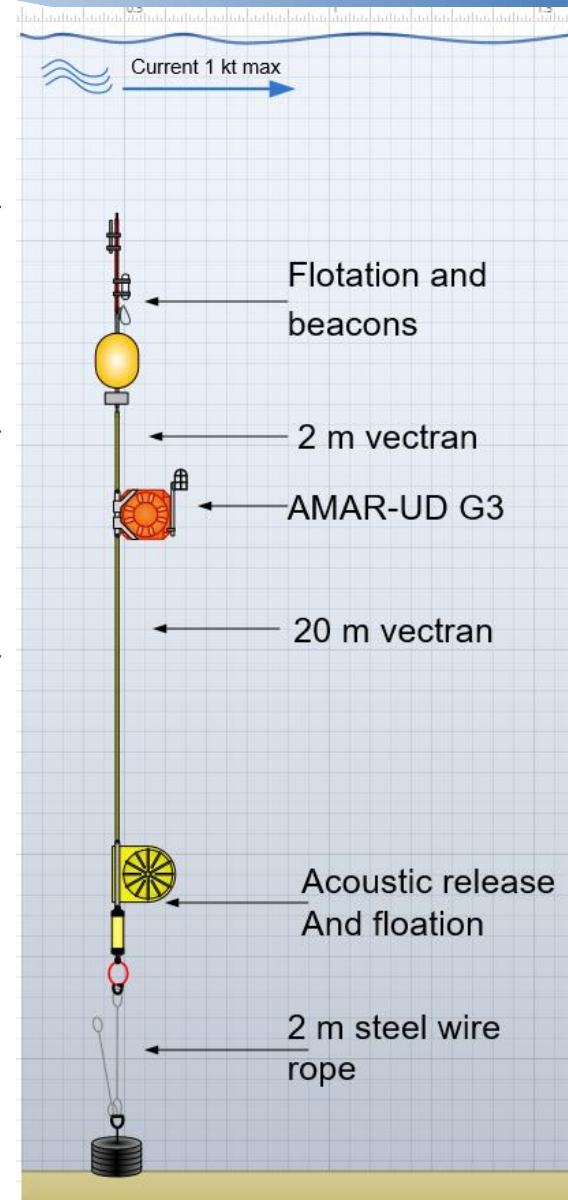
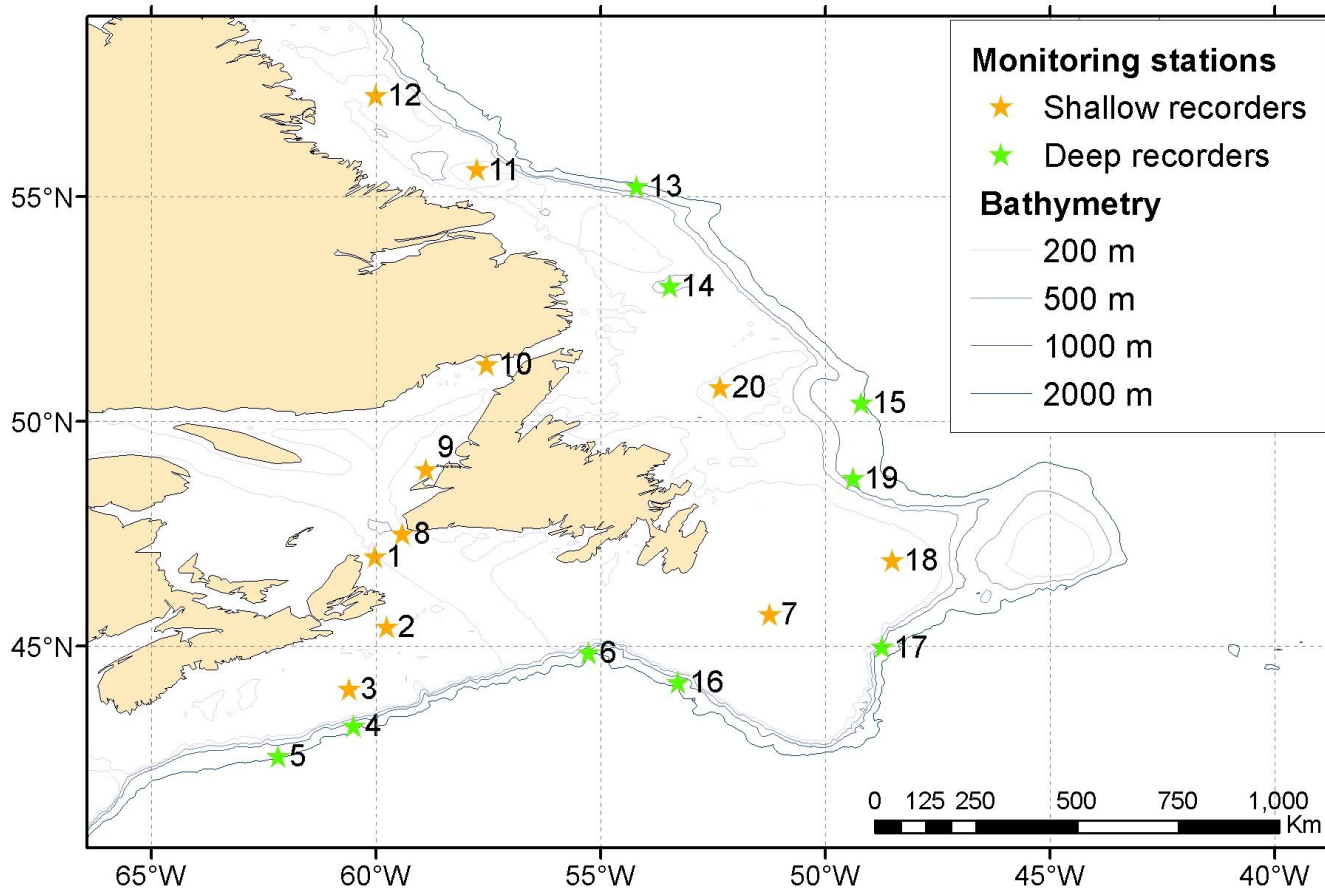


Recording to Prediction

- Use the odontocete click detections from a year-long wide-area acoustic monitoring program to predict probabilities of encountering odontocetes on Canada's east coast.



Recordings

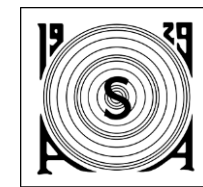
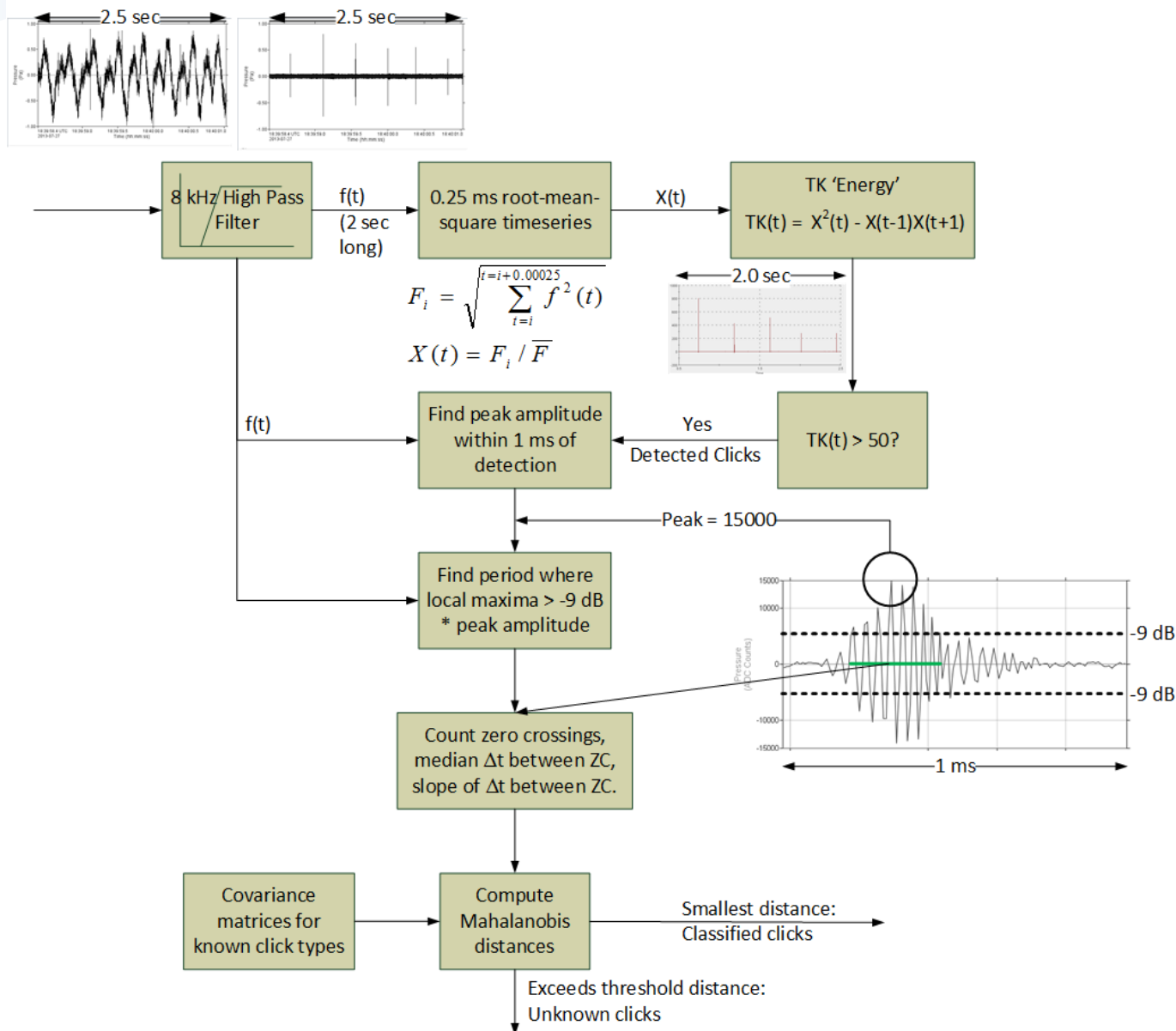


- 1-min in 20 @ 250 ksp
- Aug 2015 – Aug 2016

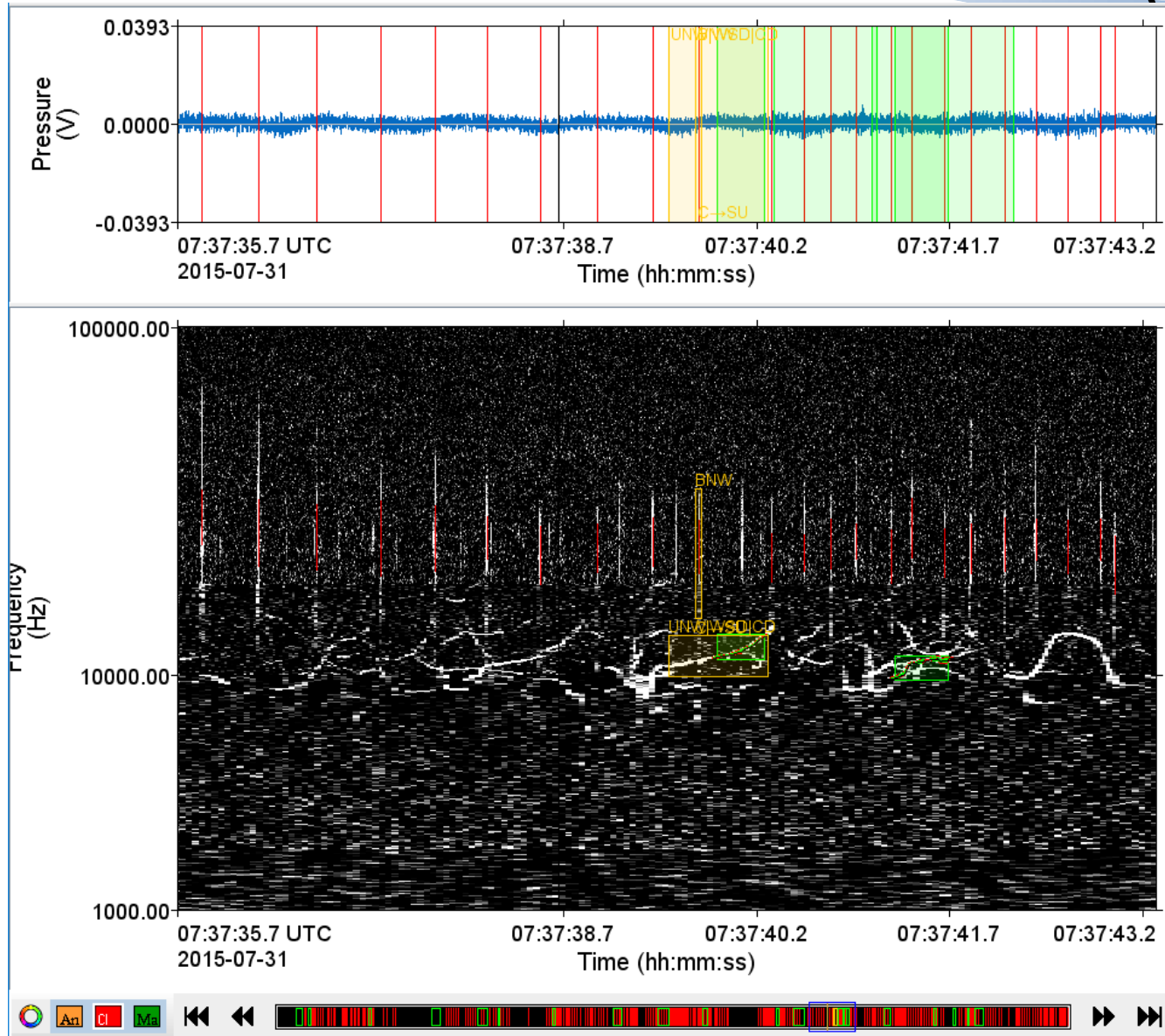
Odonotocetes on the east coast

Toothed whales			
Short-beaked common dolphin	<i>Delphinus delphis</i>	Not at risk	Not listed
Striped dolphin	<i>Stenella coeruleoalba</i>	Not at risk	Not listed
White-beaked dolphin	<i>Lagenorhynchus albirostris</i>	Not at risk	Not listed
White-sided dolphin	<i>Lagenorhynchus acutus</i>	Not at risk	Not listed
Bottlenose dolphin	<i>Tursiops truncatus</i>	Not at risk	Not listed
Risso's dolphin	<i>Grampus griseus</i>	Not at risk	Not listed
Killer whale	<i>Orcinus orca</i>	Special concern	Not listed
Long-finned pilot whale	<i>Globicephala melas</i>	Not at risk	Not listed
Harbour porpoise	<i>Phocoena</i>	Special concern	Threatened
Sperm whale	<i>Physeter macrocephalus</i>	Not at risk	Not listed
Cuvier's beaked whale	<i>Ziphius cavirostris</i>	Not at risk	Not listed
Sowerby's beaked whale	<i>Mesoplodon bidens</i>	Special concern	Special concern
Northern bottlenose whale	<i>Hyperoodon ampullatus</i>	Endangered ²	Endangered ²
Blainville's beaked whale	<i>Mesoplodon densirostris</i>	Not at risk	Not listed
Gervais beaked whale	<i>Mesoplodon europaeus</i>	Not assessed	Not listed
True's beaked whale	<i>Mesoplodon mirus</i>	Not at risk	Not listed

Detection



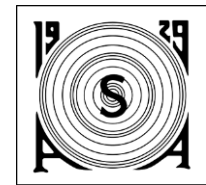
Validation I: manual review of 0.5% (N=2280)



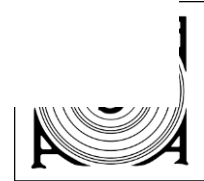
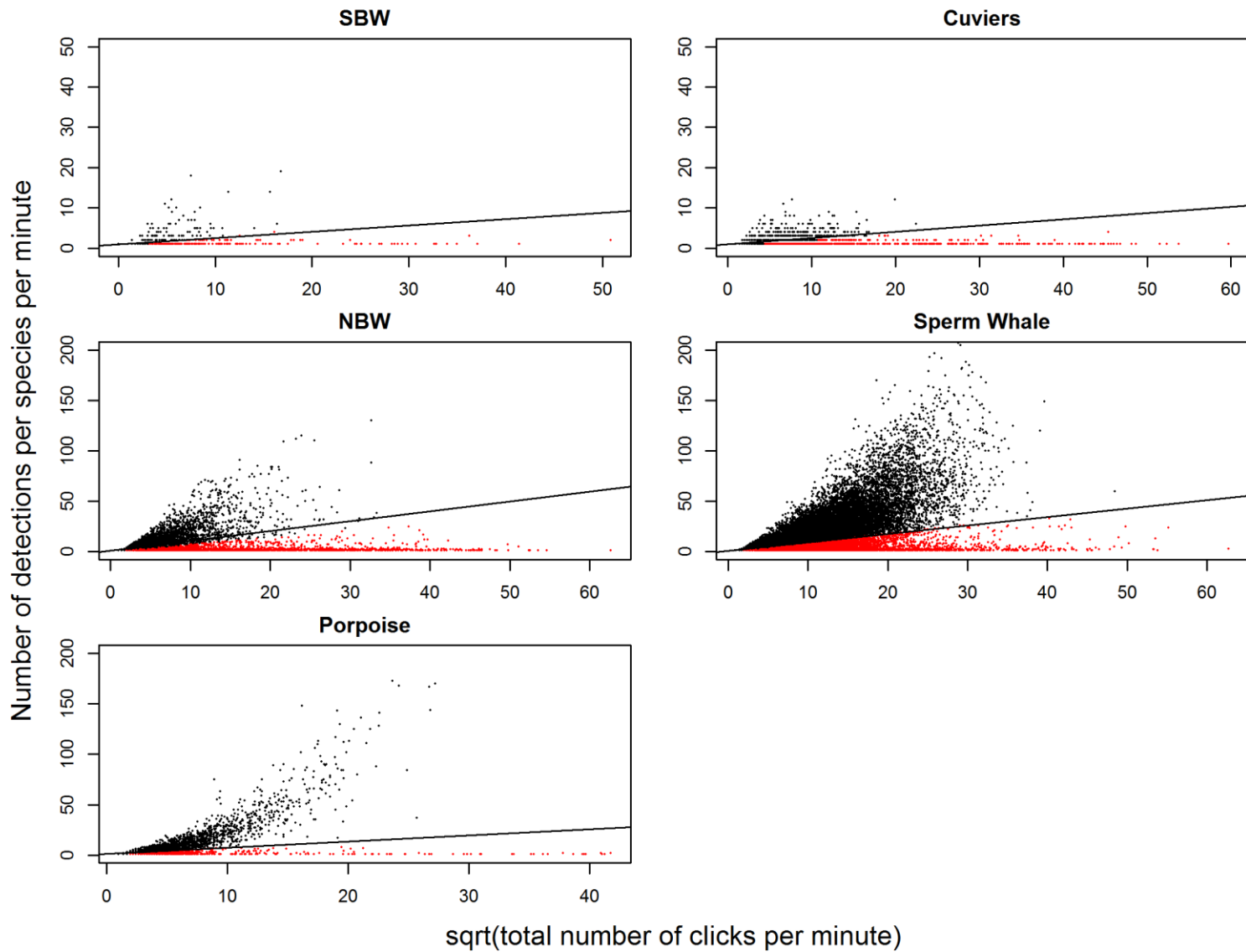
Validation Results

Species/call	P_{original}	R_{original}	Classification threshold	$P_{\text{threshold}}$	$R_{\text{threshold}}$	$F_{\text{threshold}}$
Cuvier's beaked whales	0.34	0.51	9	0.85	0.31	0.63
Northern bottlenose whales	0.85	0.73	1	0.85	0.73	0.82
Sowerby's beaked whales	1	0.94	2	1	0.94	0.99
Delphinid click	0.72	0.68	15	0.90	0.47	0.76
Porpoise	0.87	0.76	3	0.93	0.63	0.85
Sperm whales	0.59	0.51	4	0.67	0.41	0.60

- Determine P/A per file
- Collapse to P/A per day
- 6273 day-recorder combinations

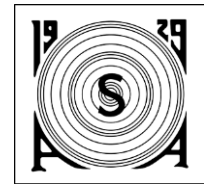


Validation II – Inflection Points



Modeling Presence

- Co-variates:
 - Depth
 - Latitude
 - Distance to 1000 m isobath
 - Date, Month or Season
 - Sea surface temperature
 - CHL-A
 - Bottom current (m/s)
 - Noise in click band
 - Wind speed
 - Ice



Un-satisfying

```
call:
glm(formula = stn$NBWDetectorPA ~ stn$Season + stn$chla.mg.m3. +
     stn$depth + stn$currrent.m.s. + stn$lat, family = binomial())
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.7370	-0.7421	-0.6084	0.9735	1.9891

Coefficients:

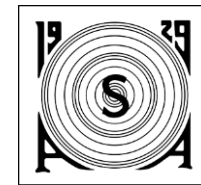
	Estimate	Std. Error	z value	Pr(> z)	
(Intercept)	-1.629e+00	3.680e-01	-4.427	9.57e-06	***
stn\$SeasonSpring	-2.067e-01	2.794e-01	-0.740	0.4595	
stn\$SeasonSummer	1.921e-01	9.314e-02	2.062	0.0392	*
stn\$SeasonWinter	-4.441e-01	7.843e-02	-5.662	1.50e-08	***
stn\$chla.mg.m3.	2.024e-04	2.831e-03	0.071	0.9430	
stn\$depth	1.227e-03	4.058e-05	30.231	< 2e-16	***
stn\$currrent.m.s.	-5.424e-04	2.713e-03	-0.200	0.8415	
stn\$lat	3.730e-03	7.204e-03	0.518	0.6046	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

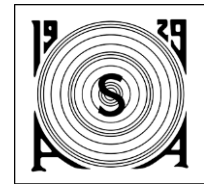
Null deviance: 8373.4 on 6272 degrees of freedom
Residual deviance: 7148.1 on 6265 degrees of freedom
AIC: 7164.1

Number of Fisher Scoring iterations: 4

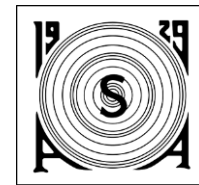
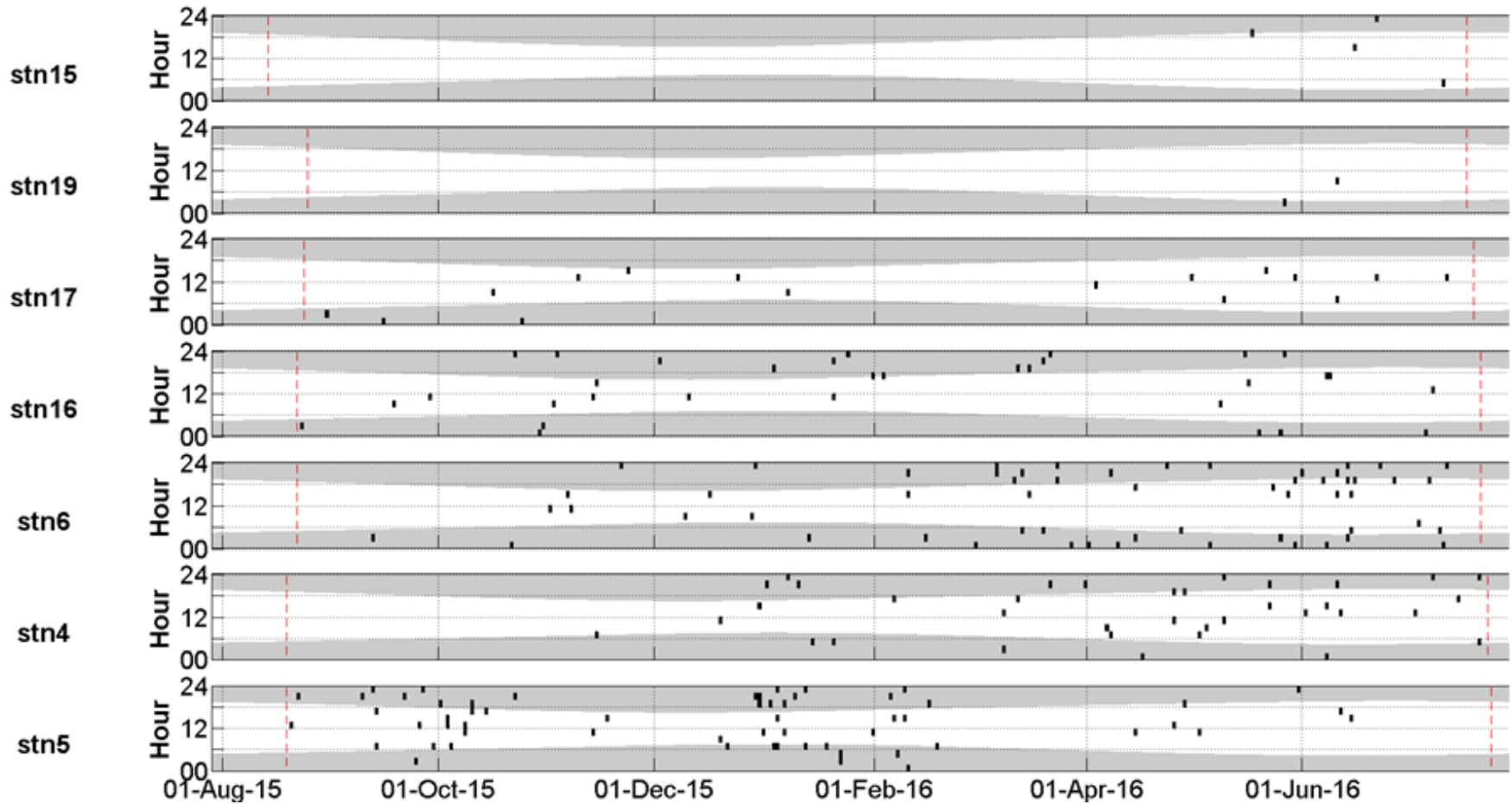


Modeling Presence

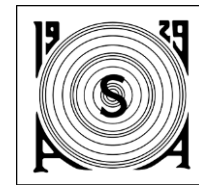
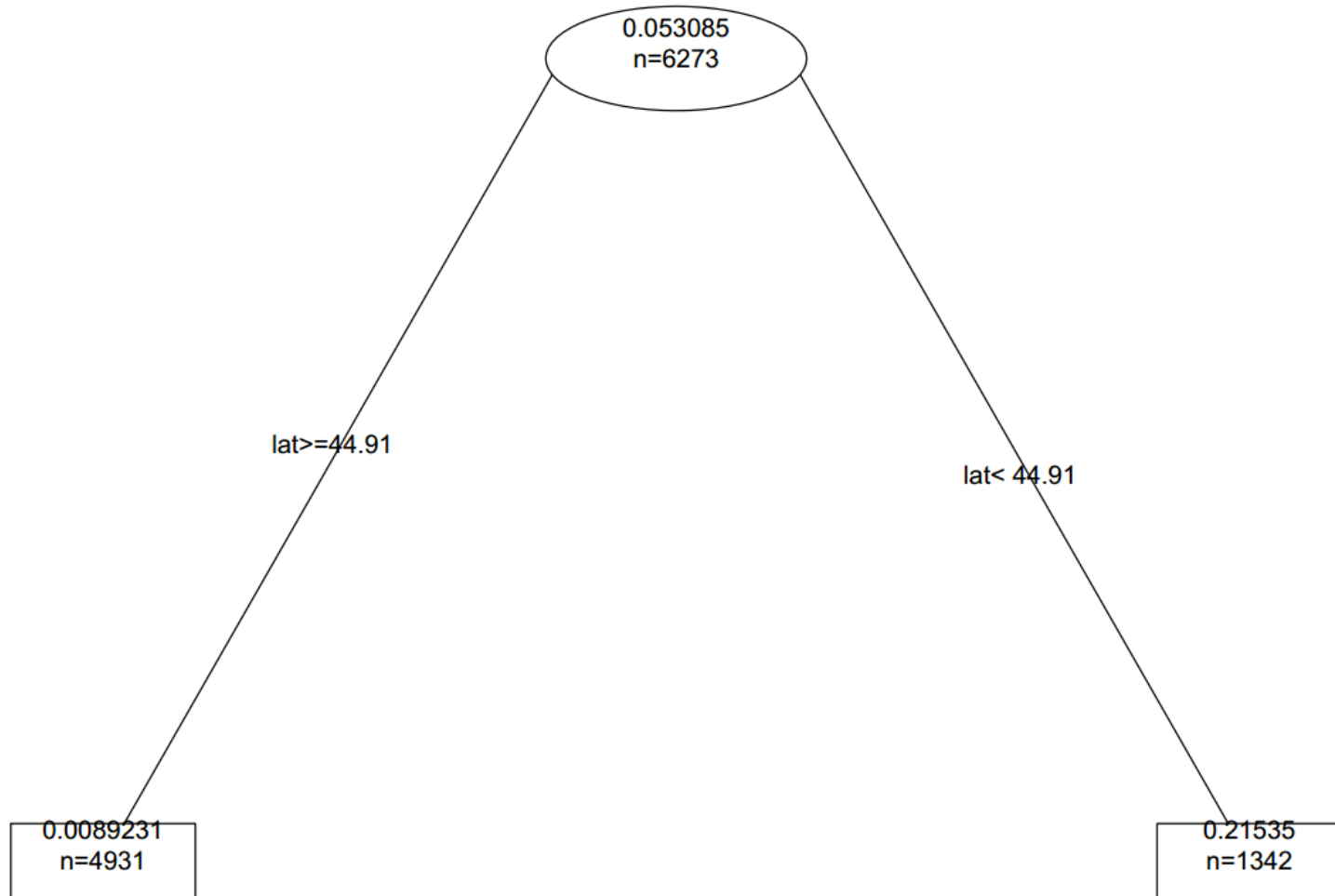
- Co-variates:
 - Depth
 - Latitude
 - Distance to 1000 m isobath
 - Season
 - ~~– Sea surface temperature~~
 - ~~– CHL-A~~
 - ~~– Bottom current (m/s)~~
 - ~~– Noise in click band~~
 - ~~– Wind speed~~
 - ~~– Ice~~



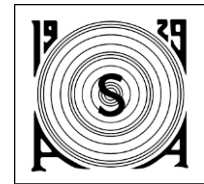
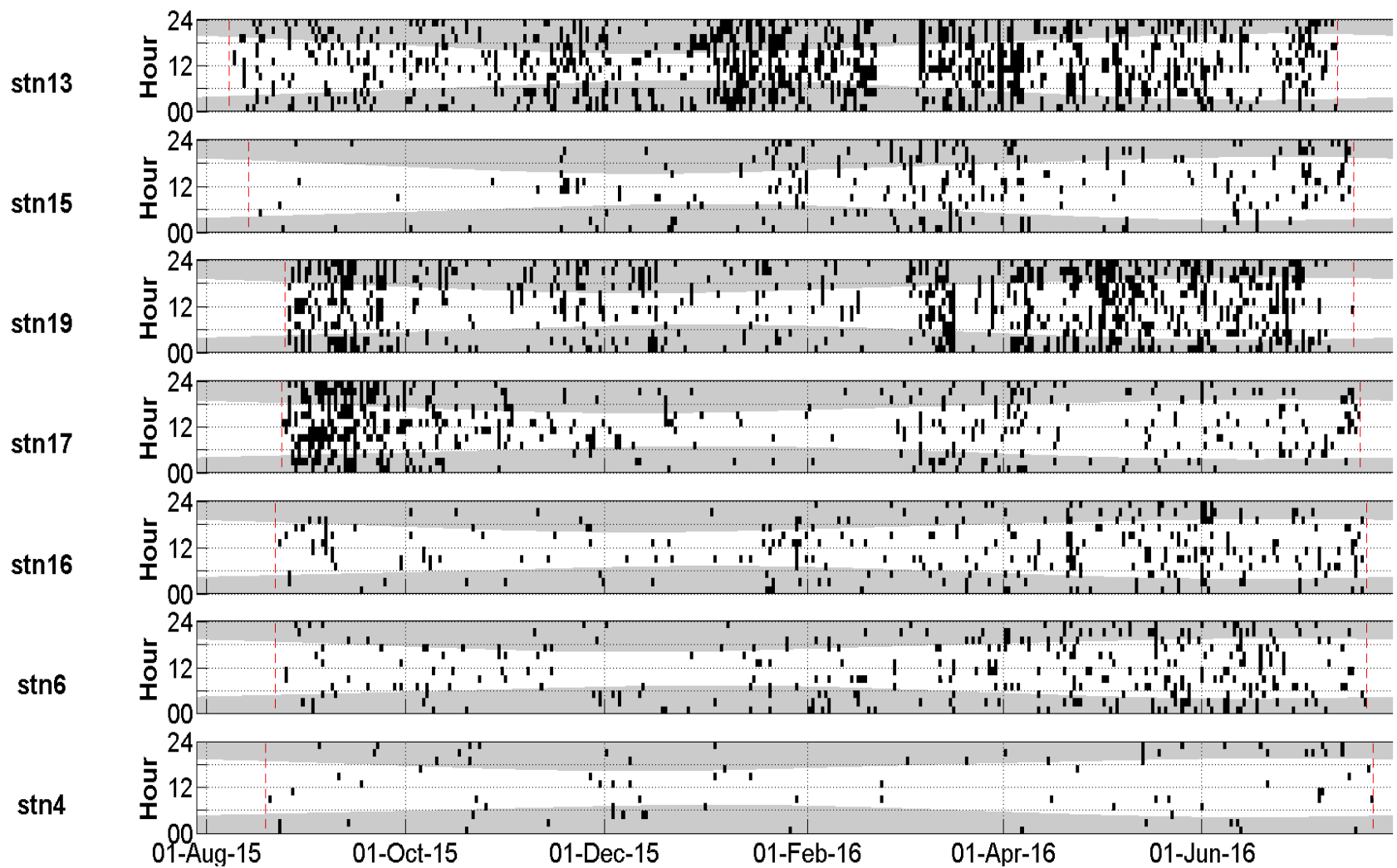
Cuvier's Beaked Whale



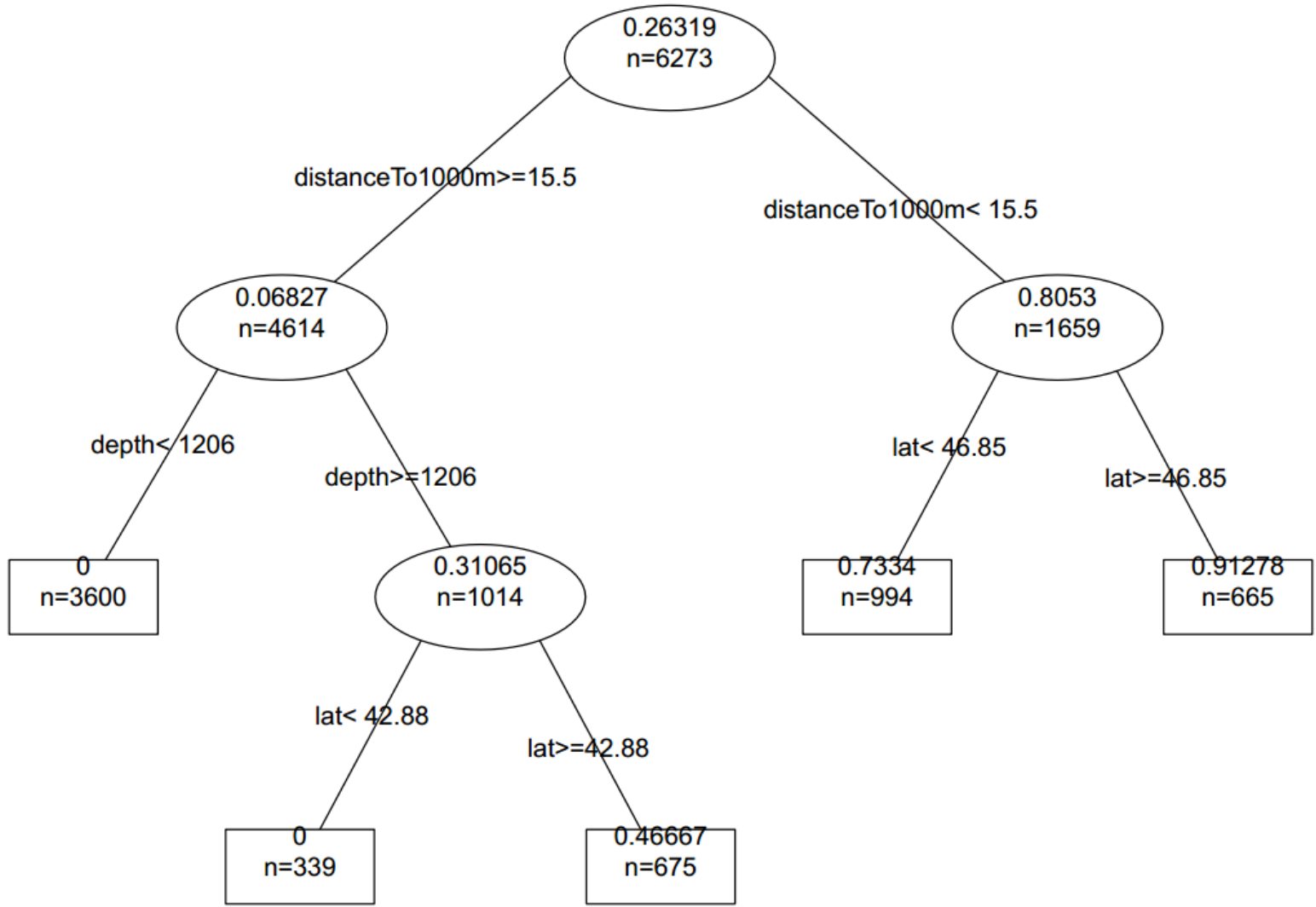
Cuvier's Beaked Whale



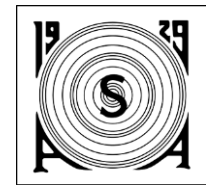
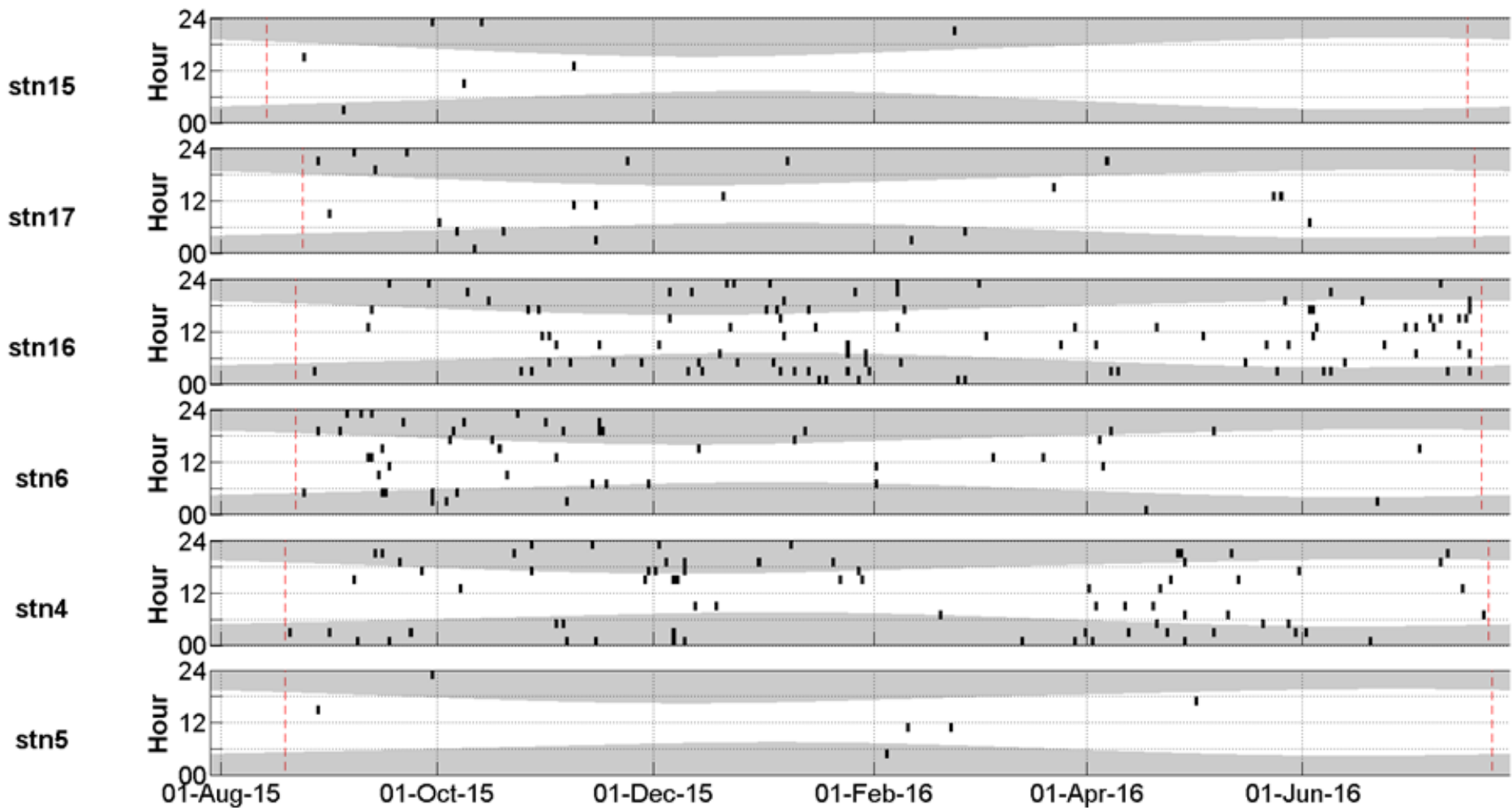
Northern Bottlenose Whales



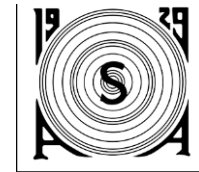
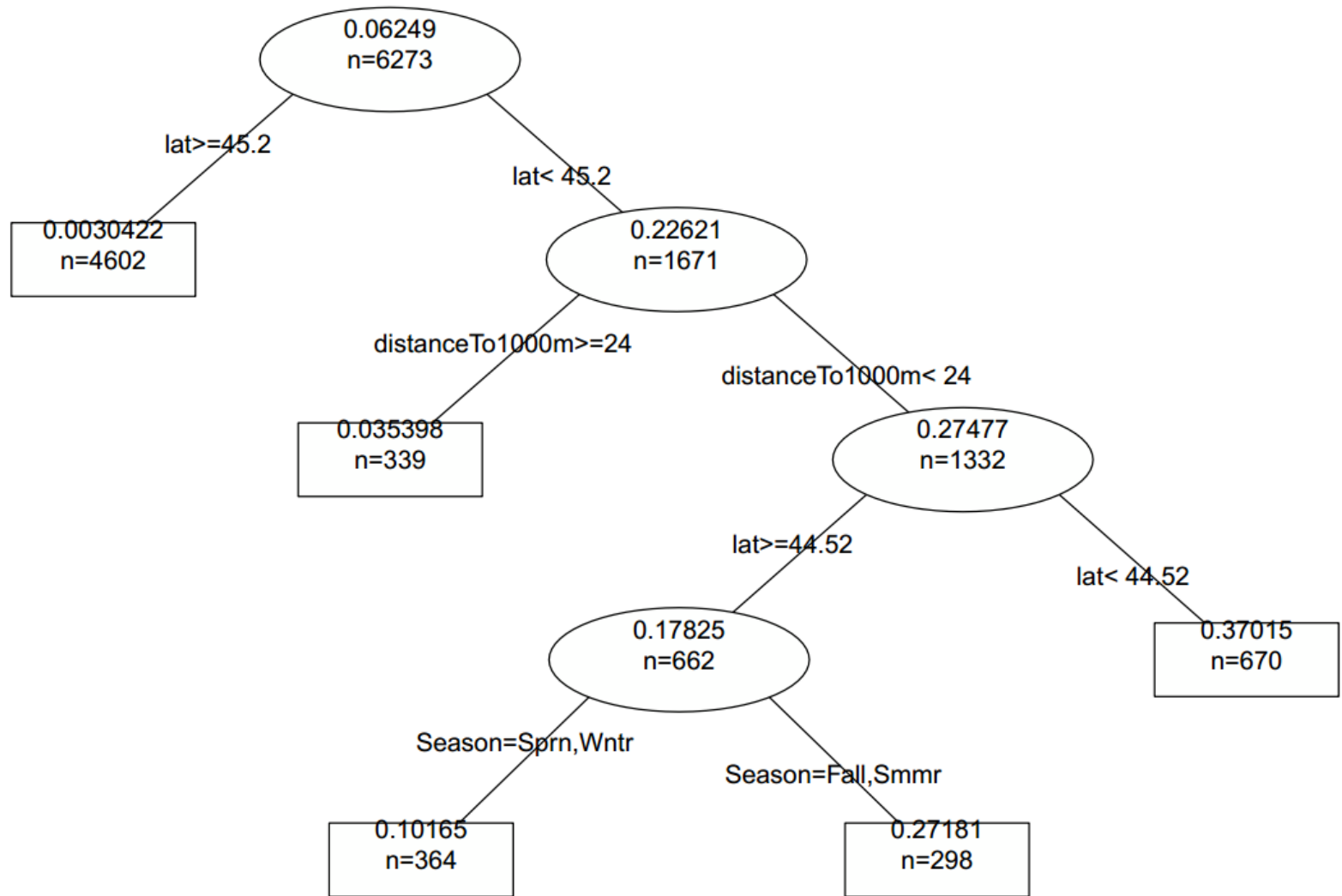
Northern Bottlenose Whales



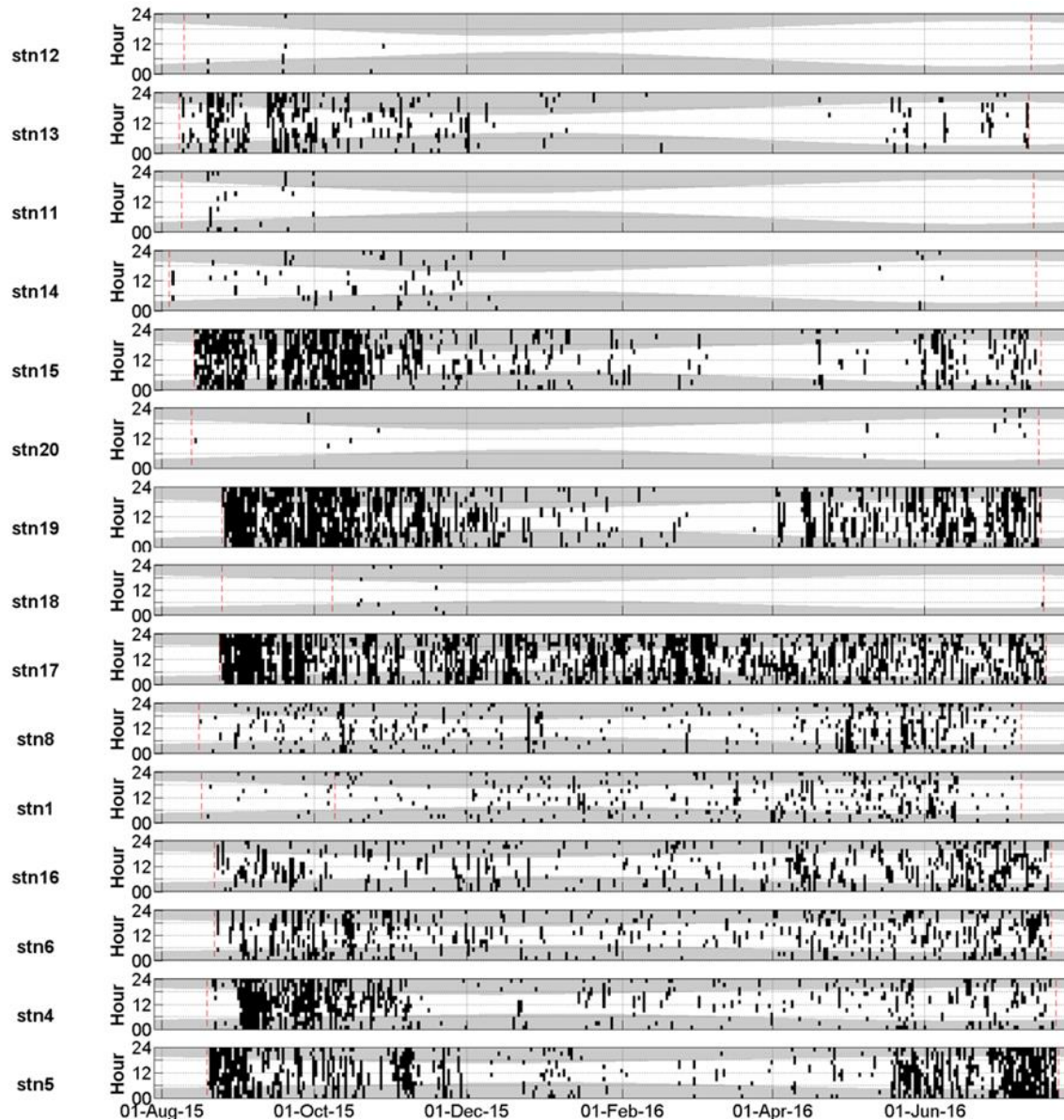
Sowerby's Beaked Whale



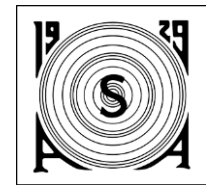
Sowerby's Beaked Whale



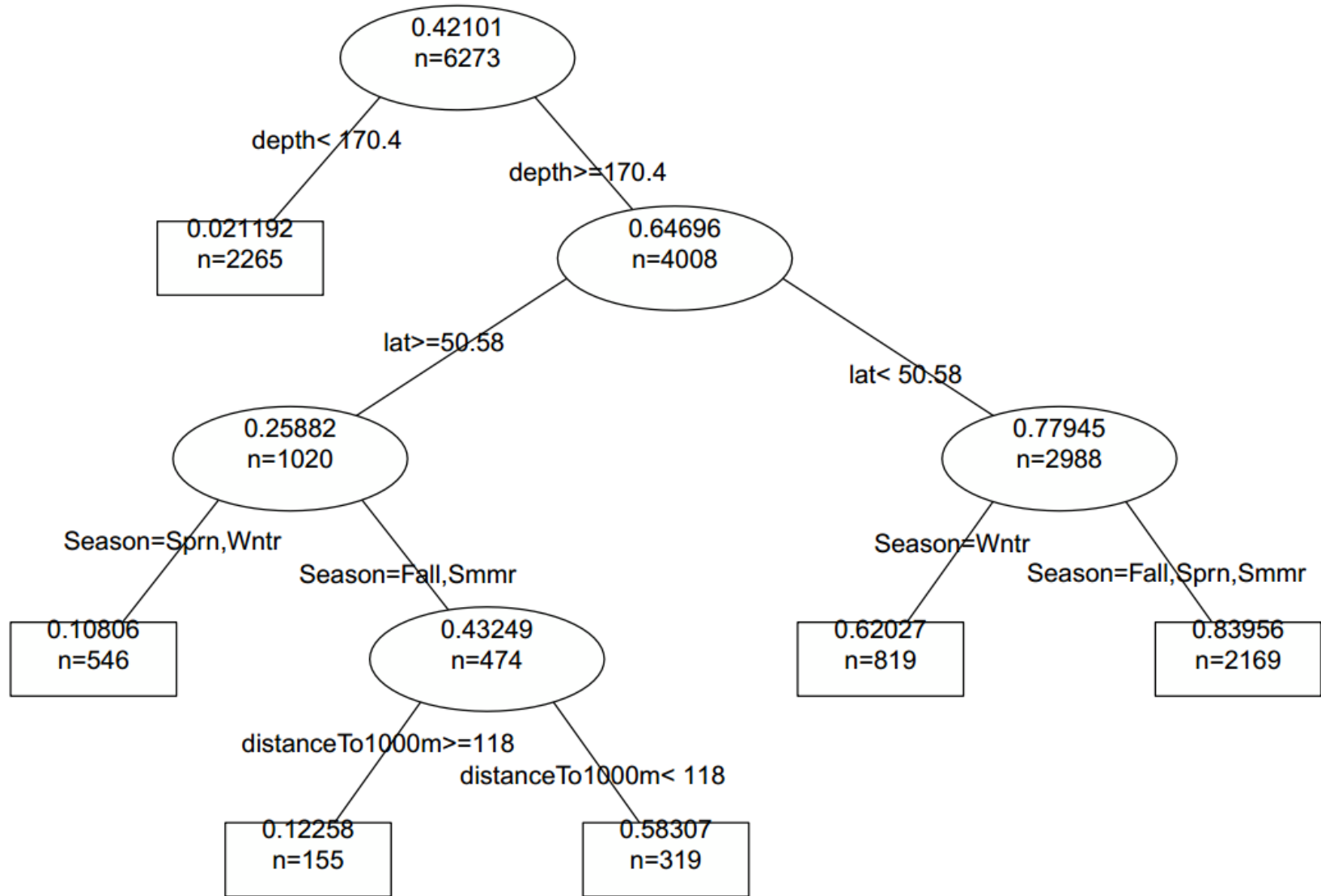
Sperm Whale



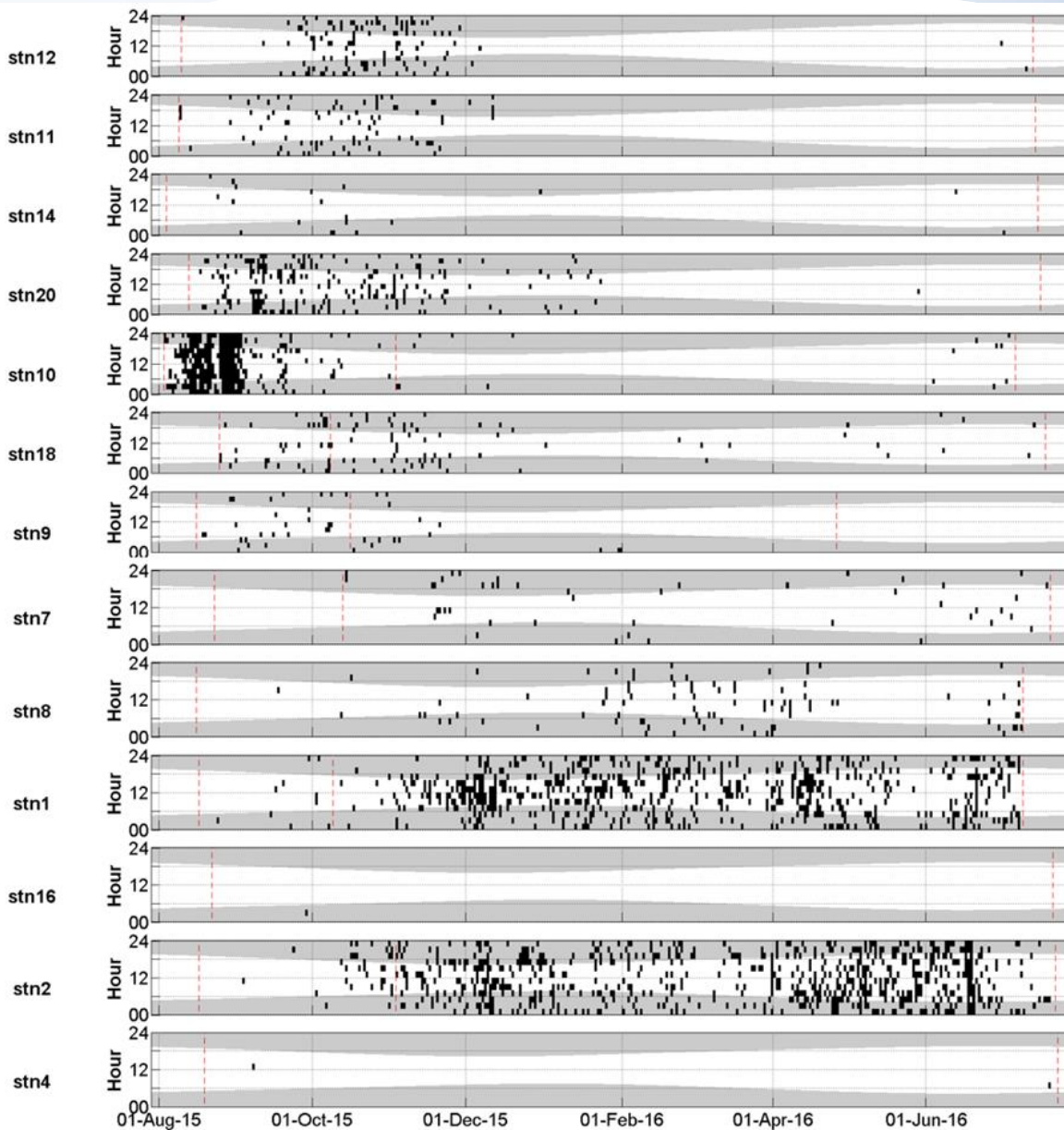
Martin et al, Eastern Canada Beaked Whales, Acoustic 2017, Boston.



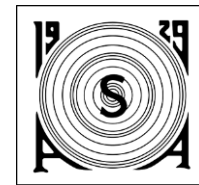
Sperm Whale



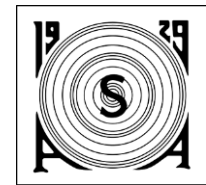
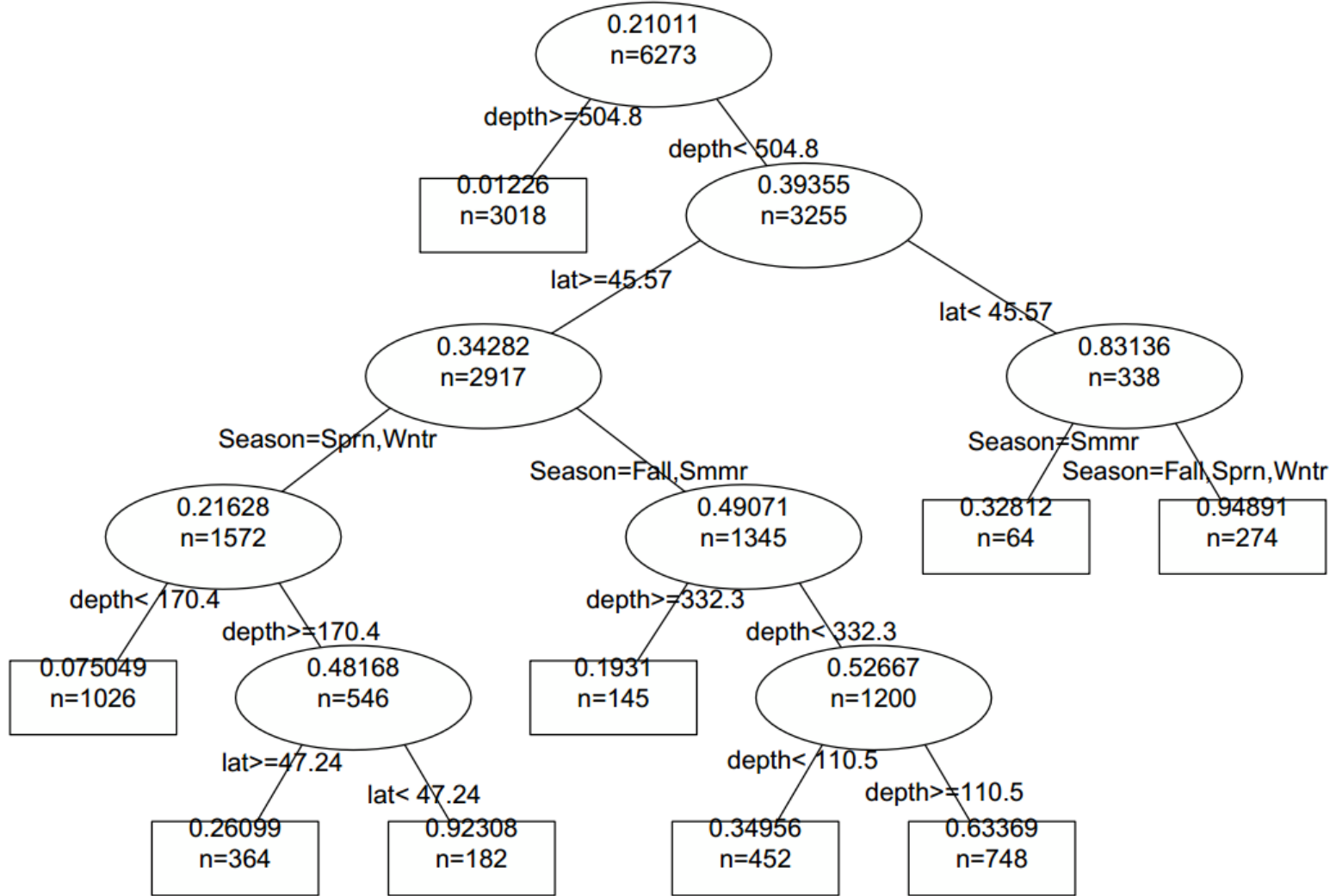
Porpoise



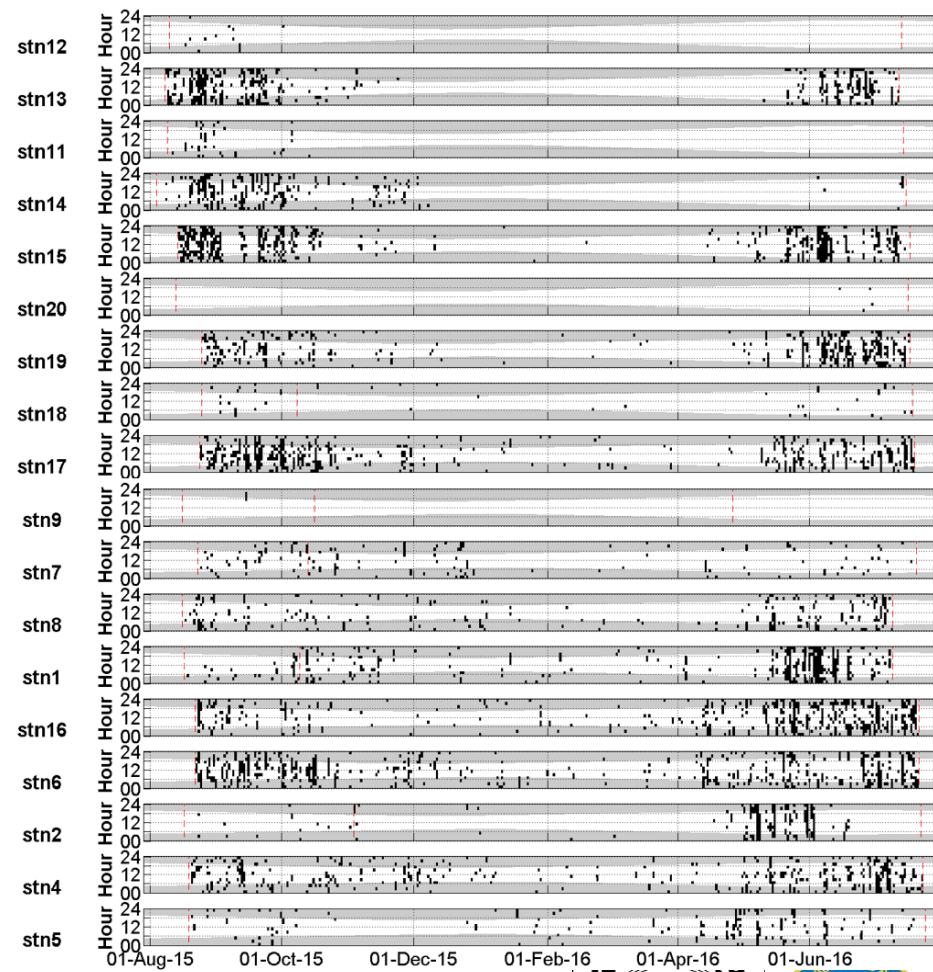
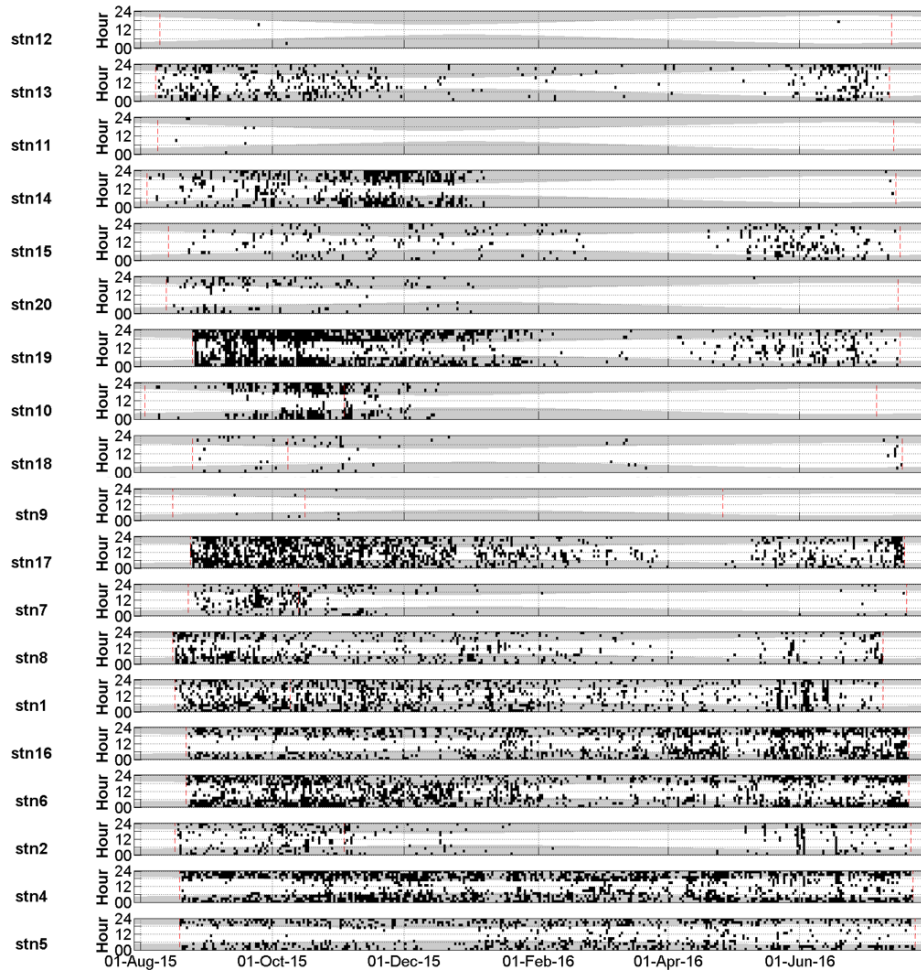
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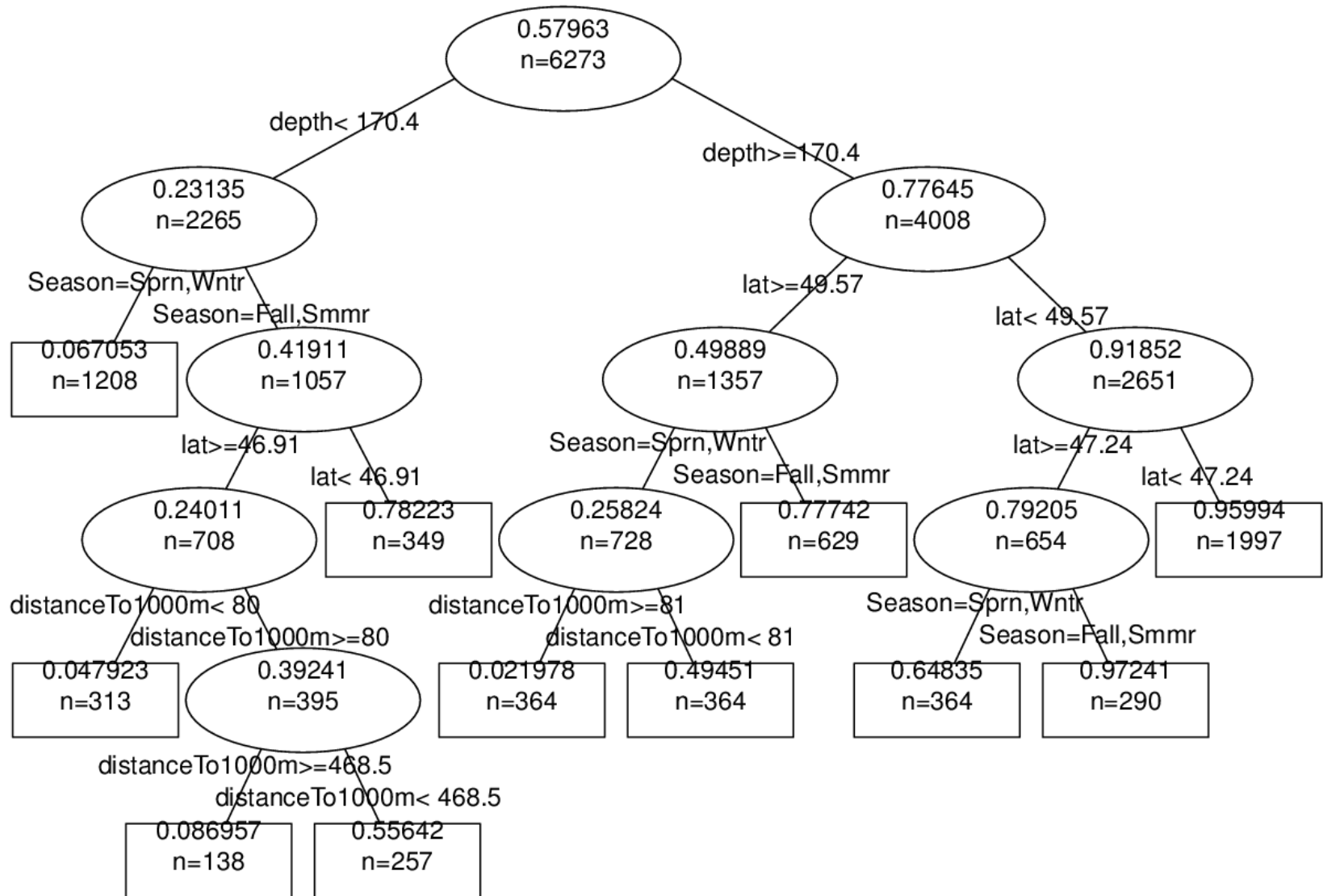
Porpoise



Dolphin & Pilot Whales

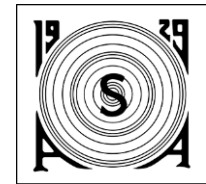


Dolphin and Pilot Whale Clicks



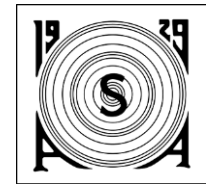
Summary

- Provided flow charts that predict the daily probability of odontocete presence based on a wide-area, year-long PAM data.
- Next steps:
 - Incorporate whistles to separate dolphins and pilots in this analysis
 - Incorporate second year of monitoring
 - Incorporate results from collaborator recorders
 - Extend to mysticetes



Acknowledgements

- **Environmental Studies Research Fund** for permission to present the East Coast Canada data.
- JASCO's field teams & the Masters and crews of all the vessels used in the ESRF program.
- Joanna Mills Flemming & Hal Whitehead for their excellent data analysis courses.



```
formulaStr = paste(spc, 'VettedPA ~  
    depth+lat+distanceTo1000m+Season', sep='')  
formu = as.formula(formulaStr)  
regTree = rpart(formu, data=stn, control =  
    rpart.control(cp = 0.01))  
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    '_PA.rpart.ps', sep=''), title=formulaStr)
```

