Cassin’s Auklet at-sea distribution and exposure to stressors such as ship-source oil pollution and microplastics

PICES, Yeosu, 23 October 2014
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Thanks also to:

- Norma Serra-Sogas – Geography, University of Victoria
- Allan Roberts - Bamfield Marine Sciences Centre
Spatial Risk Analysis Model

Risk = Likelihood x Consequence

Likelihood
of stressor

Consequence
of stressor should it occur
Cassin’s Auklet (CAAU)

- Long-lived/low reproductive rates
- ~55% global population breeds on Triangle Island
- Breeding: vulnerable to higher frequency smaller scale stressors
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Triangle Island
Cassin’s Auklet (CAAU)

Current efforts in Canada to ensure CAAU conservation:
• Scott Island Marine National Wildlife Area (MWA)
• Review for designation for protection under Species at Risk Act (SARA)

Risk assessment:
• At-sea foraging distributions
• Stressors
Exposure for Cassin’s Auklet

At-sea survey data
- Ships of Opportunity
- 1995-2010
- Breeding (15 Mar – 31 Aug)
Exposure for Cassin’s Auklet

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Exposure for Cassin’s Auklet

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Radiotelemetry
- Triangle Island breeders
- 1999-2001

Random Forest

- Variables:
  - Response = Density
  - Temporally constant predictors
    - Latitudes/Longitudes
    - Proximity (colonies, shore, canyons, shelf break, sea mounts)
    - Bottom topography (depth, slope, aspect, rugosity)
  - Temporally variable predictors
    - SST, SST gradients, Chl$_a$, Sea-Surface-Height
    - Proximity to eddies
    - Years, Julian days
- Ensemble of 500 trees with minimum nodesize of 5
- Cross-validation techniques
  - Out Of Bag (OOB)
  - Random subsampling (30 iterations)
Random Forest

Prediction Accuracy

Out of Bag (OOB)

- Mean Standard Error (MSE) = 39.1
- Pseudo-$r^2 = 0.882$

Cross-Validation (20 iterations)

- MSE = $42.5 \pm 2.2$
- Pseudo-$r^2 = 0.867 \pm 0.038$
Microplastic distribution

Desforges et al./Marine Pollution Bulletin (2014)
Oily Discharges

Traffic as a proxy for likelihood
Oily Discharges

Traffic as a proxy for likelihood
Vessel tracks of known polluters

Photo courtesy of Ken Morgan
Polluter and CAAU
Conclusion

- Increased Consequence = CAAU aggregated breeding distributions makes them particularly vulnerable to coastal stressors
  - Likely exposed to microplastics – not clear how vulnerable/sensitive CAAU are
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- Are current Canadian efforts to ensure their conservation sufficient?
  - Scott Island Marine MWA
    - Boundary designation
    - Enforcement legislation, policy, infrastructure
  - Species at Risk designation for protection
    - Trends dependent
    - Little precedent for protecting marine habitat
Conclusion

• Random Forest works well for CAAU (apparently)
  – Compare with other SDM techniques/ensemble modeling
  – Predict radiotelemetry (1999-2001)
  – Compare and predict satellite tracking (current)
Thank You!

감사합니다
Variable Importance

Variable Importance for CAAU

- Eddy_Dist
- OD_Grad
- CAAU_Dist
- Chl
- OD_Sld
- MSLA
- Terr_Rug
- Y_Coord
- X1000iso
- Shore_Dist
- SeaMtn_Dis
- OD_Slope
- Canyon_Dis
- SST_Grad
- X_Coord
- OD_Aspect
- julianDay
- SST
- Tidal_Curr
- Month
- OD_Mean

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- julianDay
- Month

%IncMSE

4 6 8 10

0e+00 4e+05 8e+05

IncNodePurity
Partial Prediction Plots

Partial Dependence on "Eddy_Dist"

Partial Dependence on "Chi"

Partial Dependence on "OD_Grad"

Partial Dependence on "CAAU_Dist"

Partial Dependence on "Canyon_Dist"

Partial Dependence on "X1000iso"