**WORKSHOP**
***Spatiotemporal analysis of ecological time series***
https://github.com/James-Thorson

**When:** Feb. 12-14, 2020 in Traynor Room at AFSC, Seattle

**Instructor:** James Thorson (HEPR), Cole Monnahan (REFM-SSMA), Cecilia O'Leary (RACE-GAP)

**Attendance**

- Maximum in-person attendance: 30 participants
- Off-site attendance: unlimited (but instructors will provide no support except streaming access)
- Sign-up: Sign-up for 2020-02 training in Seattle
- Principle for selecting attendees: 2-3 people per program (for AFSC/NWFSC programs) or institution (for academic and/or other science centers/agencies)
- Final selection will be made by Dec. 13, 2019

**Remote access:**

Join Hangouts Meet

meet.google.com/tpr-hczg-qwz

Join by phone

+1 226-213-8281 PIN: 872 489 231 9362#

**Class materials**: See google drive: 2020-02 -- VAST training in Seattle

**Installation instructions (to be completed ahead of time):**

**1.** Install R and TMB, and check that its working:
https://github.com/nwfsc-assess/geostatistical_delta-GLMM/wiki/Steps-to-install-TMB
- If necessary, install compiler/command line developer tools (Windows/macOS):
  - https://github.com/kaskr/adcomp/wiki/Download

**2.** Install R package FishStatsUtils: `devtools::install_github("james-thorson/FishStatsUtils")
- macOS: Ensure that gfortran version is installed (8.2 also works for macOS >10.14)
  - https://github.com/fxcoudert/gfortran-for-macOS/releases

**3.** Install R package VAST: `devtools::install_github("james-thorson/VAST")
**4.** Confirm that VAST is working by following the script here:
https://github.com/James-Thorson-NOAA/VAST/wiki/Simple-example

**Learning goals:**

- Day 1: Provide background for VAST, and show how to use User Manual, reference documentation, and simple examples
- Day 2: Demonstrate how to incorporate covariates, change the extrapolation-area, and explore standard outputs

- Day 3:  Demonstrate multivariate models, e.g., for use in expanding age-composition data, generating ecosystem indices, expanding stomach contents, and analysing life-history

**Day #1** – Vector autoregressive spatio-temporal (VAST) models for stock, habitat, and climate assessments

| Time | Topic | Materials | Readings |
|---|---|---|---|
| 9-9:30 (JIM) | Overview of VAST<br>● Types of assessment<br>● Case study examples | ● Thorson 2019 Fish Res -- VAST decision tree.pptx | (Thorson 2019a) |
| 9:30-10 (JIM) | Examples of current uses<br>● Combine northern and eastern Bering Sea<br>● Spatially varying coefficients | ● Thorson [Not published] -- Combine EBS and NBS data for pollock 2018 SAFE.pptx<br>● Thorson 2019 Limnology and Oceanography -- spatially-varying coefficient models.pptx | (Thorson 2019b) |
| 10-11 (JIM) | User resources for VAST<br>● User manual<br>● Reference docs<br>● Simple examples | VAST website and wiki https://github.com/James-Thorson-NOAA/VAST/#user-resources-for-learning-about-vast<br><br>VAST inputs & outputs reference docs | |
| 11-11:30 | Break | | |
| 11:30-12:30 (JIM) | Code tutorial for VAST, and interpretation of standard outputs | Simple examples on wiki: www.github.com/James-Thorson-NOAA/VAST/wiki | |
| 12:30-1:30 | Lunch | | |
| 1:30-2:00 (JIM) | Bootstrap simulator | Bootstrap example on wiki: https://github.com/James-Thorson-NOAA/VAST/wiki/Simulatori | |

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|---|---|---|---|
| 2:00-3:00 (JIM) | Discussion of previous simulation testing | | (Brodie *et al.* In press; Grüss *et al.* 2019; Johnson *et al.* 2019) |
| 3:00-3:30 | Break | | |
| 3:30-5:00 | Work in teams on topics identified during class (instructors will circulate) | | |

**Day #2** — Covariates, extrapolation-area, and standard outputs

| Time | Topic | Materials | Readings |
|---|---|---|---|
| 9-10 (COLE) | Density and catchability covariates | [Cole will provide materials] | |
| 10-11 (JIM) | Formula interface and tutorial | https://github.com/James-Thorson-NOAA/VAST/wiki/Specifying-covariates | |
| 11-11:30 | Break | | |
| 11:30-12:30 (CECILIA) | Defining new extrapolation areas | [Cecilia will provide materials] | |
| 12:30-1:30 | Lunch | | |
| 1:30-2:30 (JIM) | Discussion of common outputs | | |
| 2:30-3:00 (COLE AND DAVE) | Acoustic data application and considerations | | |
| 3:00-3:30 | Break | | |
| 3:30-5:00 | Work in teams | | |

**Day #3** –VAST and multivariate modelling options, e.g., for use in expanding age-composition data, generating ecosystem indices, expanding stomach contents, and analysing life-history

| Time | Topic | Materials | Readings |
|---|---|---|---|
| 9-10 (CECILIA) | Expanding age-composition data | Thorson and Haltuch 2018 CJFAS -- Spatio-temporal expansion of composition data.pptx<br><br>https://github.com/James-Thorson-NOAA/VAST/wiki/Expand-age-and-length-composition | (Thorson and Haltuch 2018) |
| 10-11 (JIM) | Joint dynamic species distribution models | Thorson Ianelli Larsen Ries Scheuerell Szuwalsky Zipkin 2016 GEB -- SDFA in Bering Sea.pptx<br><br>https://github.com/James-Thorson-NOAA/VAST/wiki/Ordination | (Thorson *et al.* 2016; Ovaskainen *et al.* 2017) |
| 11-11:30 | Break | | |
| 11:30-12:30 (JIM) | Empirical orthogonal functions | Empirical Orthogonal functions: Thorson Ciannelli Litzow [In preparation] -- Pacific biological oscillation.pptx | In review |
| 12:30-1:30 | Lunch | | |
| 1:30-2:00 (JIM) | MICE in space | Thorson Adams Holsman 2019 Fish and Fisheries -- MICE in space.pptx<br><br>https://github.com/James-Thorson-NOAA/VAST/wiki/MICE-in-space | (Thorson *et al.* In press) |
| 2:00-2:30 (ARNAUD) | Stomach content data | | |

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|---|---|---|---|
| 2:30-3:00 (ARNAUD) | Relative condition factor | | |
| 3:00-3:30 | Break | | |
| 3:30-5:00 | Work in teams on topics identified during class (instructors will circulate) | | |

**Works cited**


Brodie, S., Thorson, J.T., Carroll, G., et al. (In press) Trade-offs in covariate selection for species distribution models: a methodological comparison. *Ecography*. doi:10.1111/ecog.04707.

Grüss, A., Walter, J.F., Babcock, E.A., Forrestal, F.C., Thorson, J.T., Lauretta, M.V. and Schirripa, M.J. (2019) Evaluation of the impacts of different treatments of spatio-temporal variation in catch-per-unit-effort standardization models. *Fisheries Research* **213**, 75–93. doi:10.1016/j.fishres.2019.01.008.

Johnson, K.F., Thorson, J.T. and Punt, A.E. (2019) Investigating the value of including depth during spatiotemporal index standardization. *Fisheries Research* **216**, 126–137. doi:10.1016/j.fishres.2019.04.004.

Ovaskainen, O., Tikhonov, G., Norberg, A., et al. (2017) How to make more out of community data? A conceptual framework and its implementation as models and software. *Ecology Letters* **20**, 561–576. doi:10.1111/ele.12757.

Thorson, J.T. (2019a) Guidance for decisions using the Vector Autoregressive Spatio-Temporal (VAST) package in stock, ecosystem, habitat and climate assessments. *Fisheries Research* **210**, 143–161. doi:10.1016/j.fishres.2018.10.013.

Thorson, J.T. (2019b) Measuring the impact of oceanographic indices on species distribution shifts: The spatially varying effect of cold-pool extent in the eastern Bering Sea. *Limnology and Oceanography* **64**, 2632–2645. doi:10.1002/lno.11238.

Thorson, J.T., Adams, G. and Holsman, K. (In press) Spatio-temporal models of intermediate complexity for ecosystem assessments: A new tool for spatial fisheries management. *Fish and Fisheries*. doi:10.1111/faf.12398.

Thorson, J.T. and Haltuch, M.A. (2018) Spatiotemporal analysis of compositional data: increased precision and improved workflow using model-based inputs to stock assessment. *Canadian Journal of Fisheries and Aquatic Sciences*, 1–14. doi:10.1139/cjfas-2018-0015.

Thorson, J.T., Ianelli, J.N., Larsen, E.A., Ries, L., Scheuerell, M.D., Szuwalski, C. and Zipkin, E.F. (2016) Joint dynamic species distribution models: a tool for community ordination and spatio-temporal monitoring. *Global Ecology and Biogeography* **25**, 1144–1158. doi:10.1111/geb.12464.