Bycatch: spatial probability analysis for leatherback turtles

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Southwest and Northwest Fisheries Science Centers

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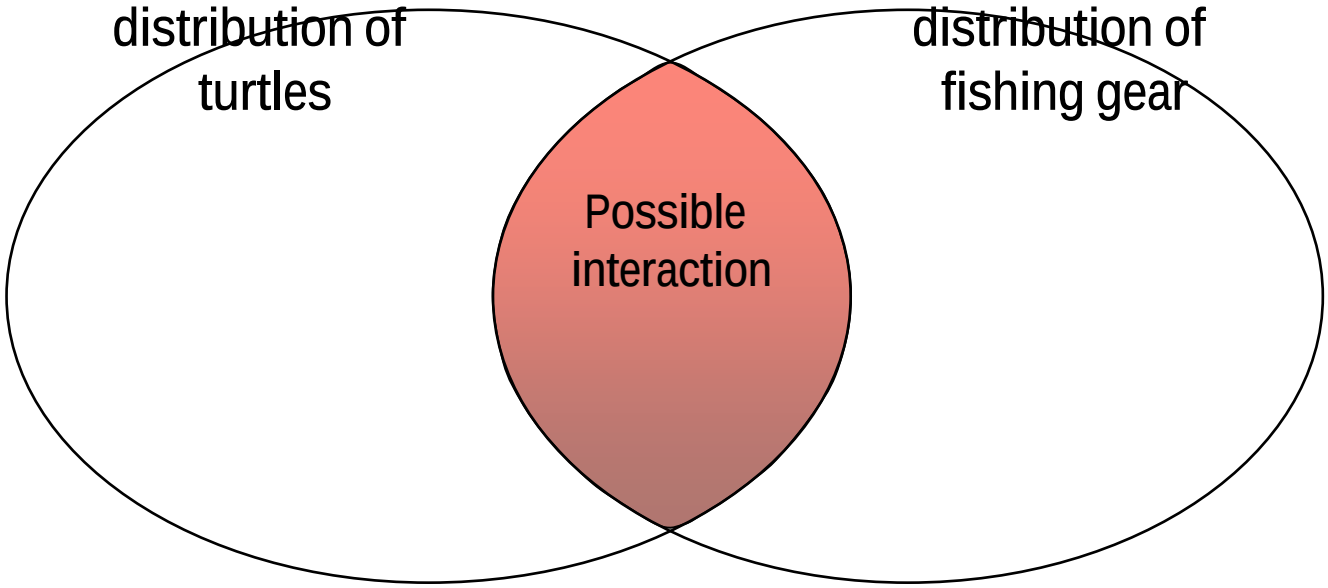
Interactions of protected species with fishing gear



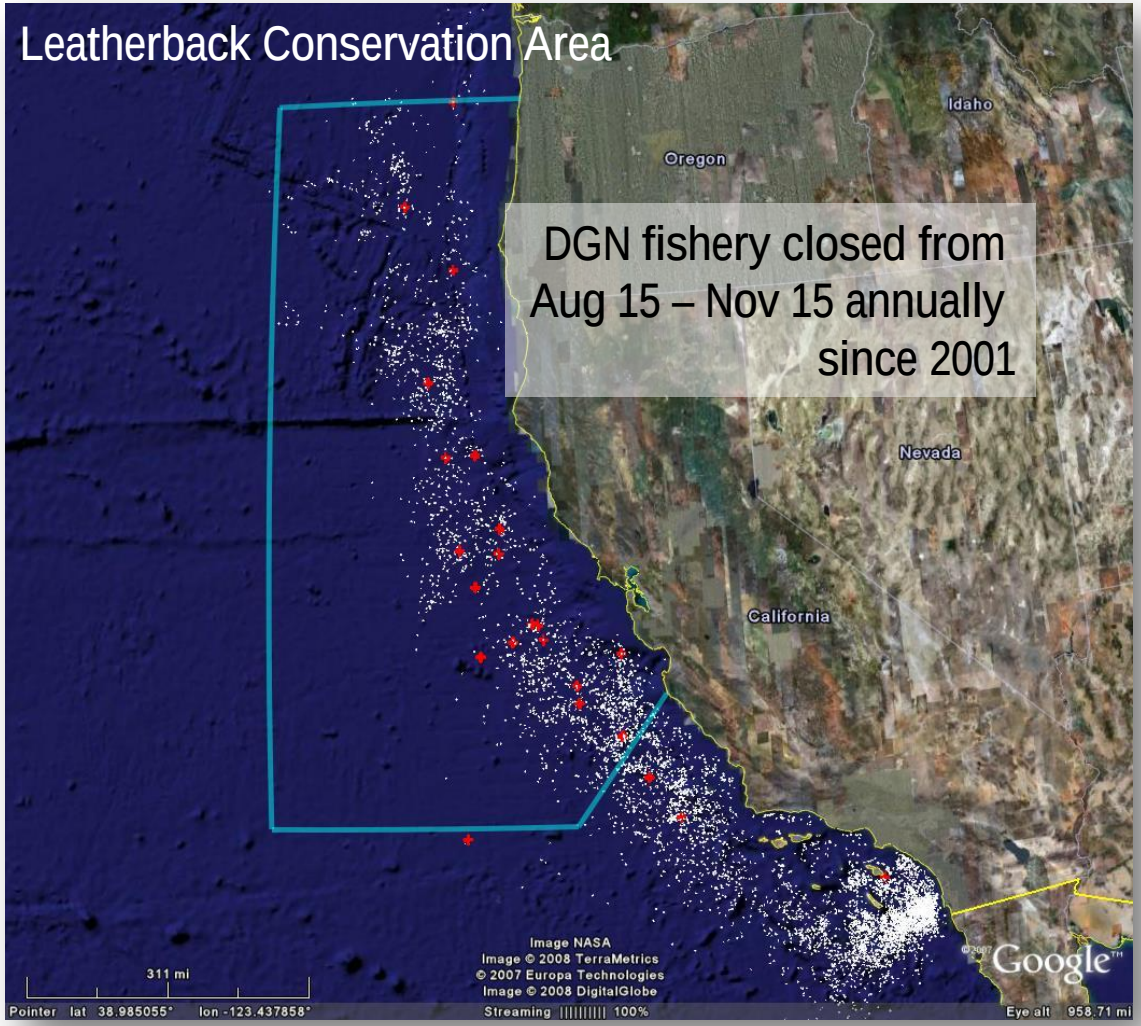
Vertical distributions should be added if enough information is available

Fishery Council is interested in developing dynamic regulations

Drift gillnet fishery and leatherback turtles as an example

Craig Heberer

Karine Forney

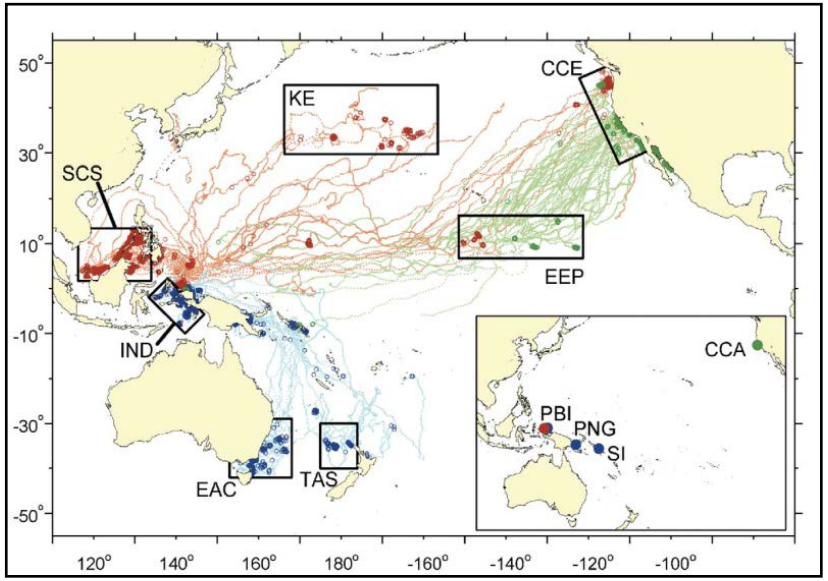


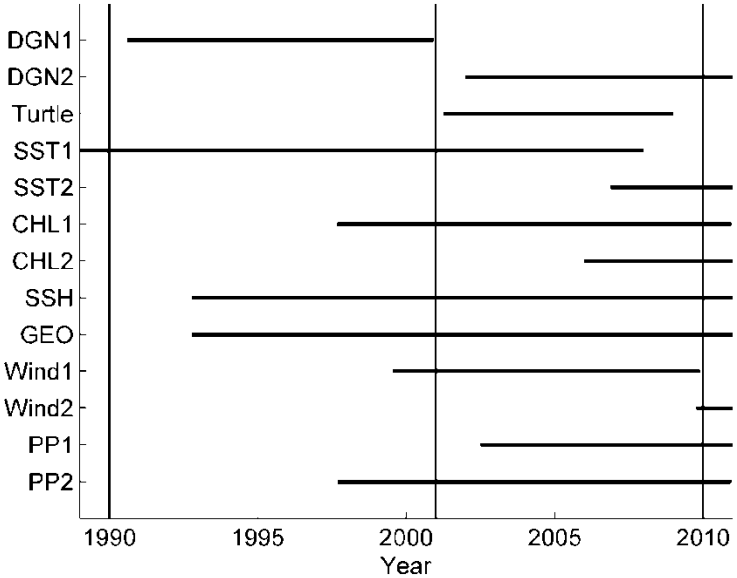
With precise prediction, fishery restrictions (time and space) may be relaxed? – Fishery Council

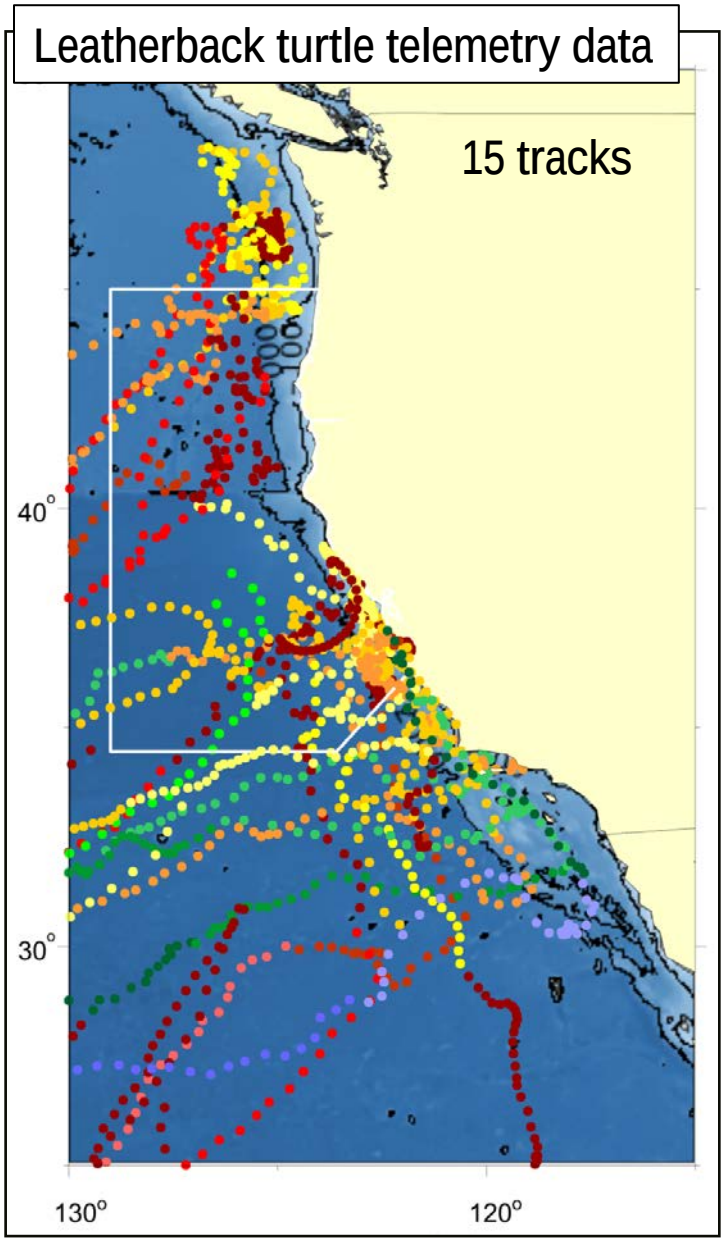
Modeling DGN fishery - leatherback turtle occurrence

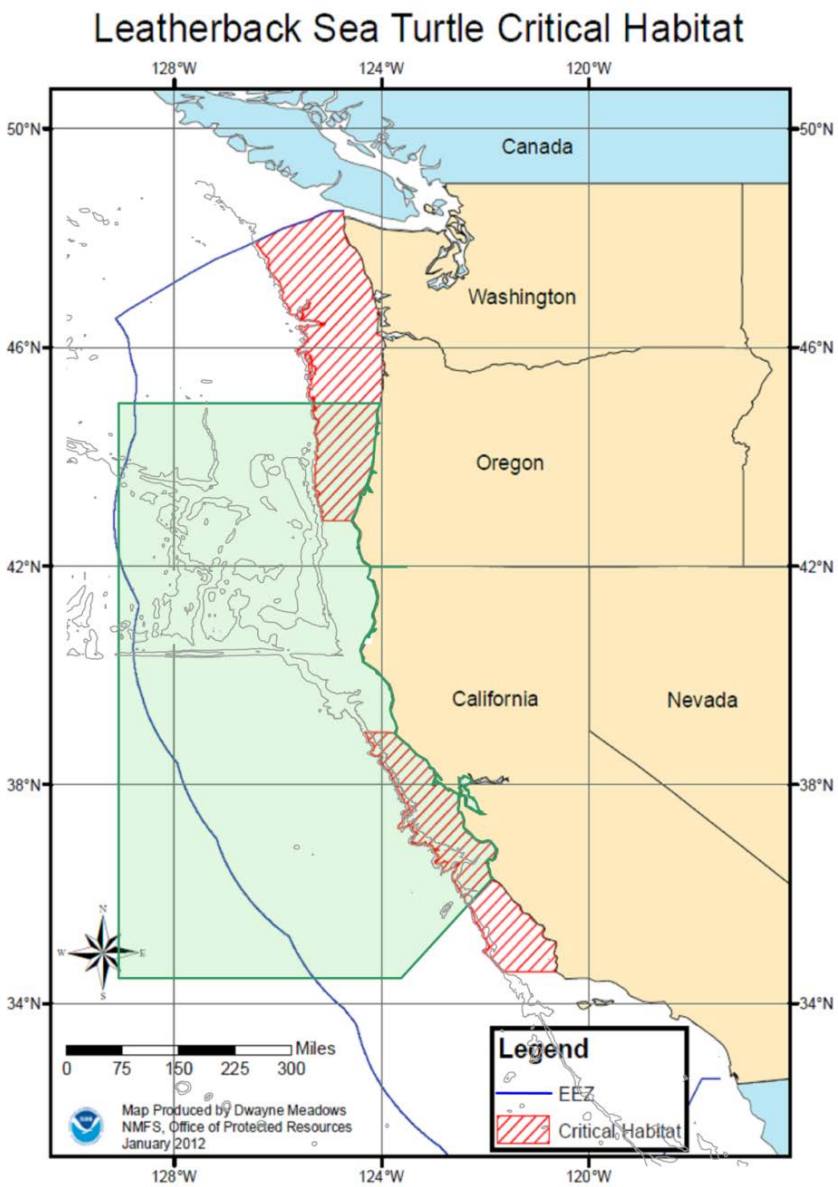
Data:

1. Satellite telemetry tracks – Benson et al. (2011) plus one from 2011 (direct attachment)
2. Only within the ecosystem (LCA +/- 1 degree)
3. Environmental data for each box
   a) time lag; 0, 8, 14, and 30 days
   b) Upwelling and oceanographic indices (NOI and PDO) – time lag






Leatherback turtle telemetry data


Leatherback Sea Turtle Critical Habitat

Modeling DGN fishery - leatherback turtle occurrence

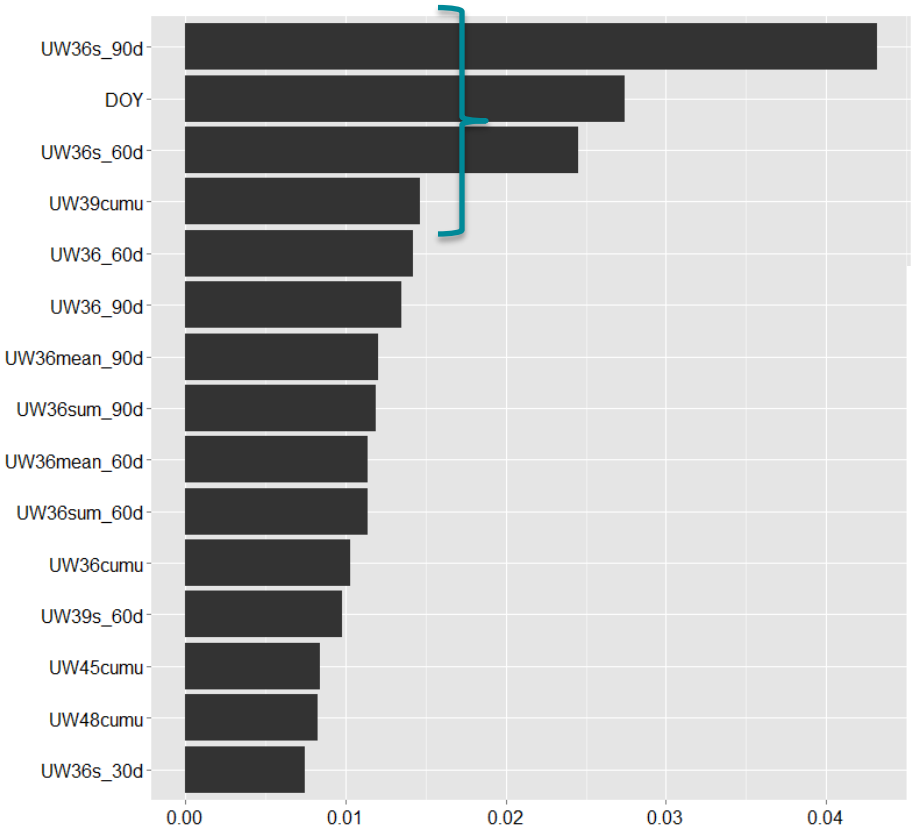
Analyses:

1. Spatial predictions of “foraging” areas outside of the critical habitat
   - Telemetered locations within the critical habitat were assumed foraging
   - Compute the predicted probability of “foraging” throughout the study area where no tracks were available
   - Random forest
   - **Difficult to validate** (not all environmental data were available for DGN period) and not particularly useful for management rules

2. **Temporal predictions of leatherback turtle occurrence in the LCA**
   - Entry and departure from the LCA with respect to upwelling (at various latitudes) and NOI and PDO with time lags – spatially coarse but available for DGN period: **can be validated**
   - Entry dataset: 30 days prior to entry (absence) to departure
   - Departure dataset: Entry to 30 days after the departure (absence)
   - Used only upwelling index, NOI, PDO Random forest to select variables, then mixed effects logistic regression (linear and non-linear models)

Results – Variable selection through Random Forest

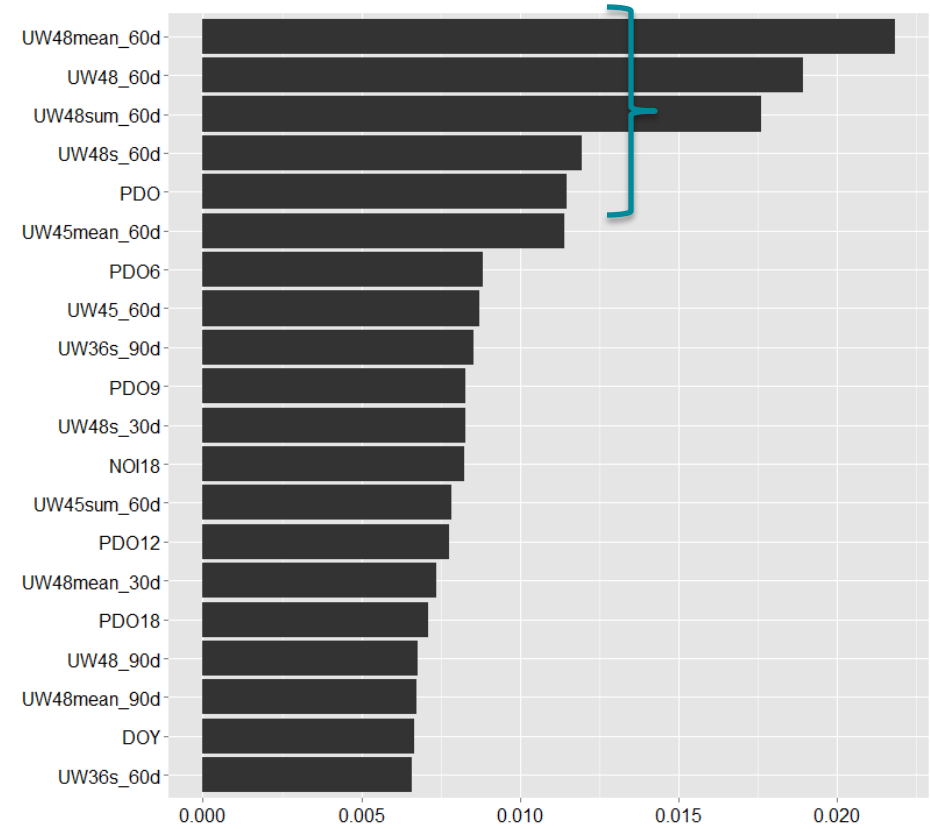
Entry dataset



UW36s_90d and UW39cumu

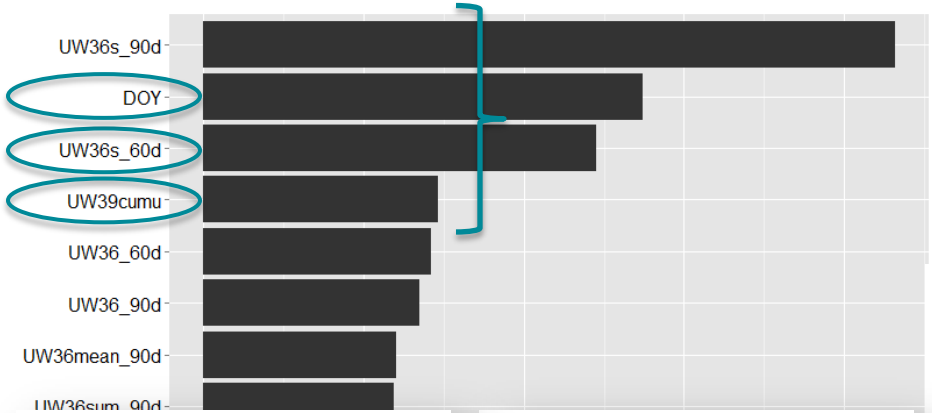
- Upwelling index at 36N
- s = standard deviation over 90d
- 90d = lagged 90 days
- cumu = cumulative

Departure dataset

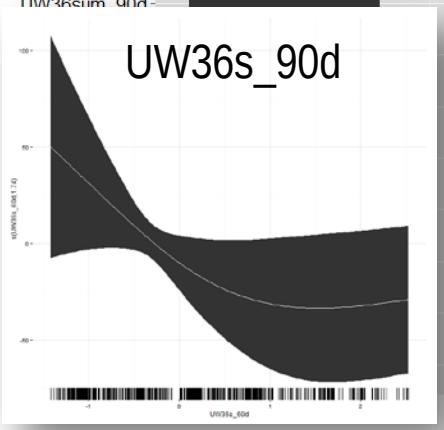


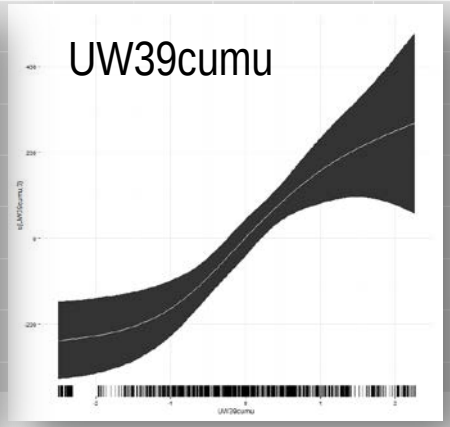
Results – Variable selection through Random Forest

Entry dataset



Removed some variables due to high correlations





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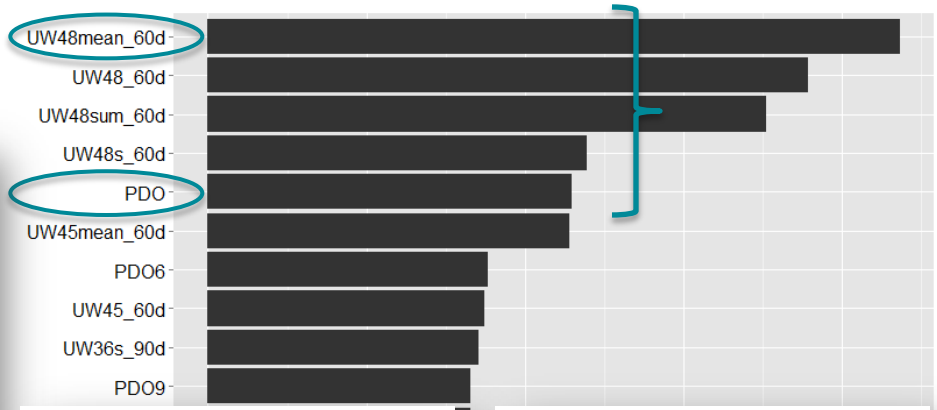
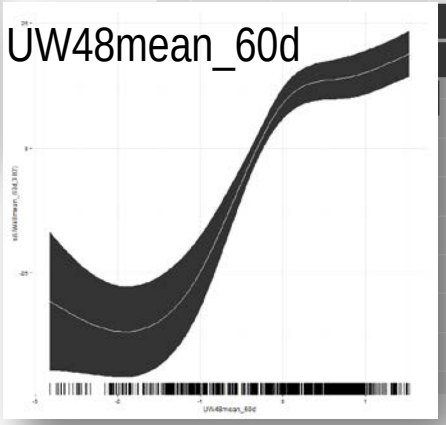
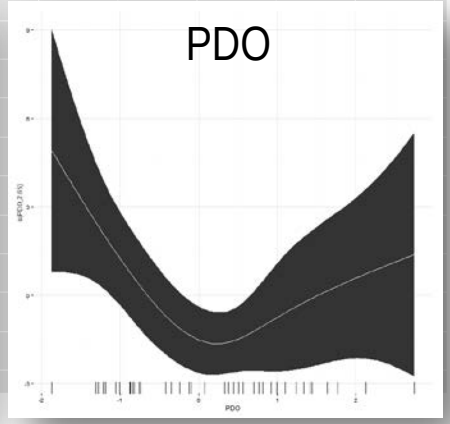
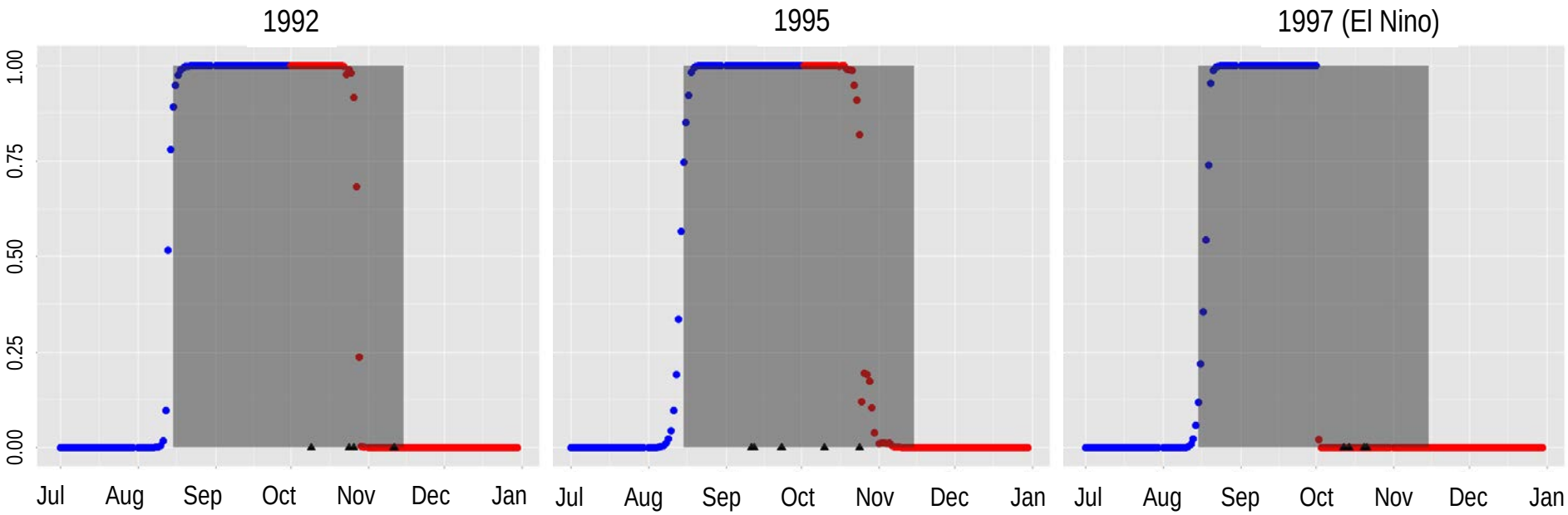






Results – Probability of leatherback turtles in the LCA

Examples of estimated probabilities of leatherback turtles in the LCA when there were observed bycatch in DGN fishery



- Gray box = DGN fishery closure since 2001 (8/15 – 11/15)
- Triangles = observed bycatch
- Beginning of the closure (8/15) matches well with increase in probability
- Departure is more difficult to predict

Modeling DGN fishery - leatherback turtle occurrence

- Leatherback turtles' arrival to and departure from the LCA can be predicted – with some errors – need to be improved
- Current closure period roughly corresponds to predicted high probability of occurrence
- Current closure period is effective
- Model predictions are limited by the data that go into them
- More data (telemetry, survey, and sightings) of leatherback turtles are necessary to refine the models
- Finer spatial scale predictions are difficult with existing data
- Current surveys don't cover the entire habitat – sightings are limited to nearshore environment
- Cost effective methods needed for surveying offshore environment