Schedule "A"

Contract Number: 238-FY12-XX

- Statement of Work –

Generation of Models in R Statistical Environment for BC Seaduck Habitat Use and BC Estuary Ranking Projects

Background:

Ducks Unlimited Canada and Environment Canada are involved in cooperative research to support the conservation of habitat for migratory waterfowl in British Columbia. A recent priority of the two collaborating organizations is the production of habitat-species models to define and predict the habitat use of waterbirds along the BC coast. Specifically, the partners have a need to develop and refine models in the 'R' statistical modeling environment for 1) coastal habitat use by seaducks and 2) estuary habitat use by waterfowl.

Models of Coastal Habitat Use by Seaducks:

The partners are interested in modeling sea duck habitat use along the BC coast to identify the habitats associated with large numbers of sea ducks and thereby prioritize areas for conservation actions. They also wish to evaluate temporal patterns and spatial changes in the abundance and distribution of sea ducks, so that we may better understand the underlying reasons for these distributions and changes.

The project team has chosen to begin by examining spatial patterns in seaduck abundance and by attempting to predict their distribution based on habitat attributes. The team also wishes to examine patterns within a season, beginning with winter (December to February), and compare patterns between seasons. The project will use the Shorezone habitat dataset collected by the Province of BC and the Coastal Waterbird Survey dataset collected by Bird Studies Canada. This will be the first attempt to create habitat-species models using the Coastal Waterbird Surveys.

The project involves eight discrete steps:

1. Obtain digital datasets and prepare for analysis. **(COMPLETE)**

2. Measure the habitat and response variables within sample units.
    a) Decide on sample units (e.g. CWS polygons).
    b) Sample the response variables of interest (e.g. presence/absence, density, richness…etc.) and summarize accordingly.
    c) Sample the habitat variables:
        i) Decide which variables to summarize, including area/proportion and distance variables.
        ii) Measure shorezone variables within each sample unit based on the length or percent of shoreline characterized by the variable of interest.
        iii) Measure herring spawn, fish farms and any other variables as either distance variables or count/area variables.

3. Exploratory analysis.
    a) Examine distribution of response and habitat variables.
    b) Produce descriptive statistics.
    c) Produce simple maps of densities, richness, etc.

4. Conduct univariate analysis to confirm original selection of variables.
    Decide whether to take an annual or monthly (e.g., across years) mean of the response variable for each sample unit or treat each survey as an independent observation.

5. Determine modeling approach.
    a) Consider mixed models with random effects for year, month, weather, sea conditions and/or visibility.
    b) Examine spatial autocorrelation.
    c) Examine multicollinearity.
    d) Define candidate model set for information theoretic (AIC) approach.

6. Write code for fitting models and run it.
    a) Consider LMER, LME or GLMER in R.
    b) If spatial autocorrelation is present, consider using an autocovariate (if not using counts for response); if using counts, options are more limited (consider transformation or using density instead).
    c) Consider whether Bayesian Approach is required.

7. Model selection, averaging and validation.
    a) AIC model selection and multimodel averaging.
    b) Examine residuals for overdispersion or patterns.
    c) Assess model fit.

6. Present results of steps 6 and 7.

Step 1 is essentially complete, and therefore the consultant will be responsible for undertaking steps 2 through 8. Step 2 should involve an initial meeting between the consultant and the rest of the project team to confirm which variables have previously been recommended for inclusion in the models. This meeting should include representatives from Ducks Unlimited Canada, Simon Fraser University (Dan Esler), Environment Canada (Kathleen Moore), Bird Studies Canada (Pete Davidson).

Model of Estuary Use by Waterfowl:

DUC has been working on a functioning habitat-species model to link the biophysical attributes of BC coastal estuaries with waterfowl census information. The model will explore whether bird density is linked with estuary size, or whether other estuary parameters such as exposure or slope are more important predictors. Some of the desired outputs are to develop estuary performance measures (bird densities) to refine the PECP Estuary Rankings, and to improve estimates of waterfowl populations.

For the current estuary model, DUC has generated preliminary statistics for waterfowl density/area in the study area based on the size of the estuary using the statistical software ‘JMP’. However, DUC wishes to convert the model to the ‘R’ statistical software environment to increase its level of flexibility and sophistication.

The estuary model involves the following three datasets:

1. Aerial observations of waterfowl in estuaries (dataset will increase over time)
2. Estuary parameters – e.g. size, ecological zone location (primarily static data)
3. Bird species attributes (primarily static data)

The most recent aerial survey data have been processed, and the next step is to build the model in R.

Project Deliverables:

1. *Seaduck Models (estimated 14 days)*
   The consultant will undertake steps 2 through 8 of the procedure outlined above for generating a model in R. In addition to providing the model, the consultant will provide a formal report including a summary of outputs from steps 6 and 7, and documentation of the steps taken and decisions made. The apportionment of time to the various steps will be decided during an initial meeting between the consultant and the project team.

2. *Estuary Model (estimated 2 days)*
   The consultant will review the data and procedures used to generate the current model in JMP, and then code this model in R. In addition to providing the model, the consultant will provide a short report including a summary of outputs, documentation of the model-building process, identification of programming issues, and recommendations for steps required to make the model fully functional. No statistical analysis is required.

Schedule:

The project will begin in February 2012. All analyses and the summary report are to be completed by March 31st, 2012.

Data:

All data will remain the exclusive property of Ducks Unlimited Canada and Environment Canada, and may not be released to other sources unless authorized in writing by Ducks Unlimited representatives.

Ducks Unlimited Canada Contacts:

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Project Technical Support	Jeanine Bond, Conservation Programs Specialist Dan Buffett, Regional Biologist Unit 511, 13370 78th Avenue, Surrey, BC V3W 0H6

Estimated Expenditures

- Daily Rate for Analyses and Write-Up (HST not included)
  (16 days @ $xxx.00 /day) $ xxxx.00 CDN

TOTAL ***$xxxx.00 CDN***