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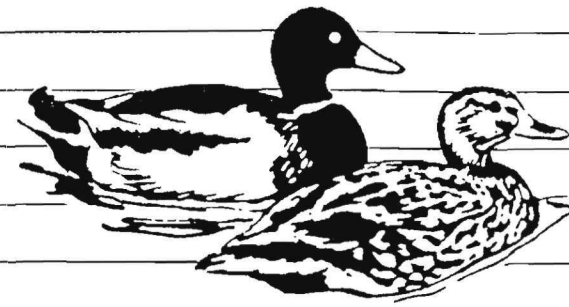

Decision-based Model of Habitat Establishment in Salt Basin Wetlands of Western North America

Success of establishment of wetland vegetation on barren salt-flat areas may be predicted with minimal knowledge of plant tolerances and of general information about growing conditions on the site. Many managers on wildlife refuges in western North America desire that wetlands produce vegetation beneficial to wildlife. The decisions currently made about wetland creation or wetland management on a specific site are (of necessity) based on incomplete information on plant species life history characteristics, seed banks, salinity, water level, and wave effects.

Model Use for Predicting Wetland Plant Establishment

We developed a wetland community model based on species attributes (traits) to predict habitat development on denuded salt flats in the western United States. Our model provides resource managers with a tool to assess the probability of plant survival under various environmental conditions. The model integrates the relative importance of biotic interactions and abiotic factors commonly thought to be limiting to plant establishment and growth in salt basin environments.

Three inland brackish wetlands in central Utah (Bear River Migratory Bird Refuge, Clear Lake State Waterfowl Management Area, and a private hunting club) were selected to test and to validate the predictive model. Each study area consisted of nonvegetated salt flats before shallow flooding.

A detailed search of literature yielded primary references outlining species growth tolerances and germination requirements under known salinity and flooding conditions. Field and greenhouse research included an investigation of seed banks to determine numbers of viable seeds resident in the soils for each plot and site. Salinity and water levels were monitored monthly on each study site during the growing season. Field experiments showed that wave disturbance was significant and that grazing by large animals was not an important cause of plant loss.

Model predictions of plant presence or absence were based on 3,024 simulations of actual study plot data under each of the following conditions: (1) presence of seeds, (2) surface water salinity (high, medium, or low), (3) inundation, and (4) exposure to wave energy. After presence or absence was determined from individual factors, all possible combinations of factors were used to make predictions. Model accuracy was evaluated by scoring each set of predictions with the actual observed plant presence or absence data collected at each of the 3,024 sites.

Model Predicts Correctly 90% of the Time

Seed presence, salinity, inundation, and wave energy combined to provide valid predictions in 90% of the trials. Model terms and prediction success are

shown in the Figure for predictions made with individual terms. The model term with the greatest predictive power was seed bank which yielded 89% accuracy. An equally noteworthy model outcome shown in the Figure is that model predictions could be made correctly almost 89% of the time using all other factors except seed presence (i.e., using salt, waves, and flooding). Because seed presence is the most difficult to measure, it is both convenient and reasonable to use salt, waves, and flooding as major inputs.

Utility of Model for Managers

Model results suggest the following:

1. Species tolerance limits to salt, flooding, and wave action provide a reliable estimate of suitable species and potential establishment success for the plants in arid regions in western North America.
2. The following list of regional plants and environmental factors is an example of a model application for an impoundment that may be permanently flooded at Bear River Migratory Bird Refuge. Only those species with no X marks in the columns would be expected to be abundant in the area. This simple model can provide resource managers with the ability to predict the range of probable habitat types that can be created or maintained under managed conditions.
3. The presence of viable seeds is the overriding predictor of plant establishment; the absence of such seeds suggests that a lag should be expected in plant establishment. Predictive model accuracy is enhanced by adequate seed bank data, and seed banks may be investigated by direct investigation of soil contents or by greenhouse germination testing of soils before wetland management. However, a complete knowledge of seed bank contents is not essential, and estimates may be derived from other factors such as germination in adjacent moist areas, proximity of seeding adult plants, or inflow transport of seed reserves.
4. Wave disturbance may prohibit plant establishment. Size and orientation to prevailing winds should be considered when planning to create or manage wetlands. Greater fetches expose shorelines to greater wave energy and thereby reduce the establishment potential of most wetland plants. In areas of high wind, a series of smaller impoundments may perform better than a single large impoundment.
5. This model is only successful if it aids insight, brings biological facts into associations with a wetland manager's intuition, or helps guide decisions through the maze of unknowns usually encountered in the planning process for wetland management. The models will provide a logical, repeatable procedure for considering a range of options and may aid decision making when other supporting evidence is unobtainable. Model performance may be greatly improved by tailoring it to specific situations and fine-tuning it on individual sites over time.

For further information or copies of the plant growth tolerance information cross-referenced with literature citations, contact:

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Table. Growing conditions.

Plant species	Salinity tolerance	Wave tolerance	Flooding tolerance	Prediction
Typha sp.	X			absent
Polygonum sp.	X			absent
Scirpus olneyi				present
Scirpus robustus				present
Potamogeton pectinatus		X		absent
Salicornia europea			X	absent
Distichlis spicata				present
Tamarix sp.			X	absent

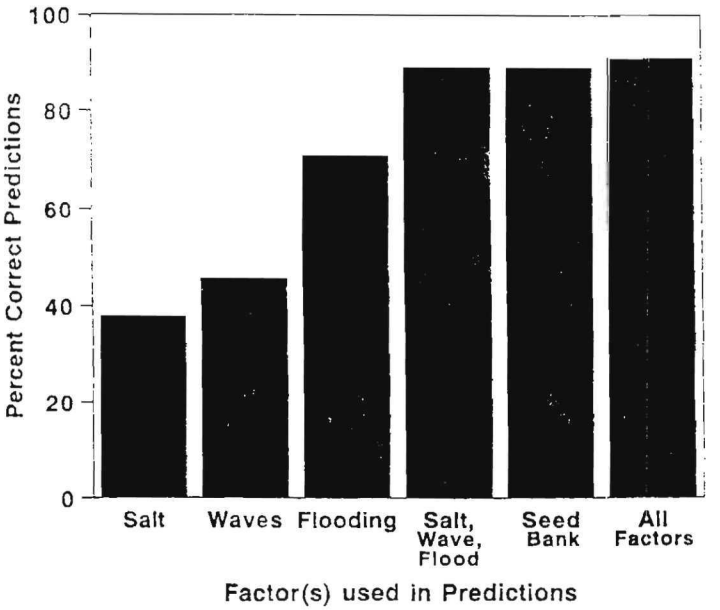

Figure. Percent correct model predictions made when using specific predictive factors. Predictions verified on 3,024 field plots in Great Basin wetlands.