Scenario-based modeling of impacts to the agricultural viability and ecological functioning of large river deltas in Puget Sound: urbanization, sea-level rise and restoration in the Skagit Delta

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I. Introduction
The Skagit Delta agricultural community has proposed that there is a critical minimum area (threshold) of agricultural acreage necessary to sustain a local agricultural economy, but no previous attempts have been to quantify the threshold. The acreage threshold has led many Skagit farmers to resist proposed local ecological restoration projects (such as habitat restoration for salmon recovery), land use regulatory changes, and land use planning that may result in conversion of agricultural land uses, including urbanization. This project will quantify the acreage threshold by simulating the seed crop “pinning process”, a local agricultural cooperative agreement that involves the allocation of acres for planting seed crops (a chosen acre receives a pin on a map). Seed crops are the focus, since they are an important regional cash crop and their acreage threshold is expected to be large relative to other crops. As the number and quality of available acres diminishes, the pinning process will be more constrained and expected seed crop yields will fall and risk to farmers will increase. Drivers include [1] increasing population growth, urbanization, and sprawl in Skagit County; [2] increasing political pressure to restore former tideflats and floodplains to recover threatened Chinook salmon; [3] uncertain regional climate change that would alter growing seasons, increase flood frequency and intensity, and increase stress on agricultural drainage systems and dikes; [4] global sea level rise that would alter the tidal zone characteristics, submerge low-lying agricultural lands, and alter soil salinities and [5] proposed landscape-scale infrastructure projects such as the US Army Corps of Engineers Skagit River flood mitigation proposal, which might consume significant acreage. Since these drivers involve large uncertainties, the model will be run under a variety of scenarios. The resulting product will be a scenario-based integrated GIS analytical environment that stakeholders (landowners, environmentalists, developers, planners, and others) can use to explore the relations between land use plans, seed crop agricultural viability, and important exogenous drivers.

II. Background
Skagit Agriculture:
Agriculture is the county’s largest industry, with an estimated 2001 production value of more than $260 million. Historically, the county has generated 50% of the world’s cabbage seed production, upwards of 85% of the nation’s beet seed production, and 75% of the world’s spinach seed production. Other significant crops include raspberries, strawberries, broccoli, potatoes, tulips, and daffodils.

Source: Skagit County Comprehensive Plan, 2007 Release

Agricultural trends over the last two reported Census of Agriculture (1997 and 1992) indicate both continued strength and some threats to the industry. Total acreage in farmland increased over this time period, and while farms grew larger - resulting in a smaller total number of farms - Skagit County farms are still on average far stronger and some threats to the industry. Total acreage in farmland increased over this time period, and while farms grew larger - resulting in a smaller total number of farms - Skagit County farms are still on average far stronger.


III. Ag Viability Model

The seed crop pinning model simulates the choosing of agricultural plots for planting a particular variety of seed crop. The seed crops are chosen based on a rotation cycle (10 - 20 years) and, because of the potential to blend varieties by cross-pollination, cannot be planted too close to a similar seed crop. Plot attributes, like soil qualities, and other yield influencing factors, are involved in the choice. There are also other institutional and economic constraints, like plot ownership (“turn taking”), yield and profit maximization motives for both farmers and seed companies, etc. Simulating the pinning process involves ranking desirable plots based on choice rules, ruling out plots due to constraints, while trying to identify sets of plots that maximize an objective function. The pinning process is simulated annually over a planning period, e.g., 20 years.

Plot Code
Choose

Constraints rule out plots based in this choice
Repeat choice algorithm until a fully pinned map emerges.

Evaluate final set of chosen plots (the “pinned map”) in terms of modeled expected yield, risk to farmers, and other objectives

Repeat process for the next year, “remembering” previous choices for relevant constraints (e.g., crop rotation cycle). Repeat entire process over planning period for the next scenario.

IV. Scenarios

The pinning process model will be run under a variety of sea level rise, climate change, urbanization, and restoration scenarios. Since each of these drivers are expected to impact the quantity and quality of acreage available for farming, each scenario offers a different set of constraints.

V. Use by stakeholders

This project will attempt to model thresholds of economic viability for the agricultural community within the Skagit Delta. By modeling changes in land use from production agriculture towards habitat restoration for fisheries, wildlife, or planned development we will explore the economic impacts to local distribution, processing and agronomic support variables. The explicit modeling of the collaborative crop rotation process in terms of local land characteristics, available acreage, and crop history will enable us to quantitatively explore economic viability thresholds under various scenarios for restoration, urban development, sea level rise, levee improvements, and other important factors. By modeling the agricultural economy in a GIS environment, visualizing these land use change scenarios will be much more straightforward for stakeholders and decision-makers.

Urbanization and restoration scenario (2028)

Sea level rise scenario (40 and 90 years)