Projecting the Long-term Effects of the 2011 Missouri River Flood on Floodplain Bird Populations

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Background and Objectives:

- Cottonwood (*Populus deltoides*) forests along the Missouri River provide important foraging and nesting habitat for migrant and resident landbirds.
- The construction of 6 large dams has effectively eliminated flooding, thereby decreasing floodplain forest recruitment.
- Despite flood control infrastructure, the Missouri River experienced a high amplitude and long duration flooding event in June–Sept 2011.
- Preliminary data analysis of bird survey data shows a temporary decline in birds the first year post-flood. Long term effects on bird populations are unknown. Using bird density estimates and land cover areas, we employed a Markov-chain analysis to project future bird abundances with and without the effects of the 2011 flood.
- This project complements ongoing research on Missouri River cottonwood forests and helps inform their long-term management by the United States Army Corps of Engineers.

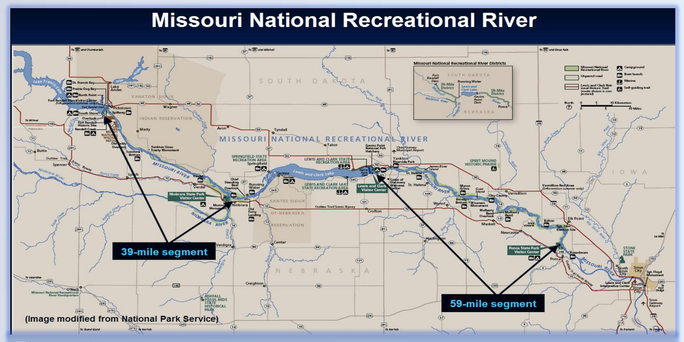

Figure 1: Map of the two study segments, as indicated by the arrows.

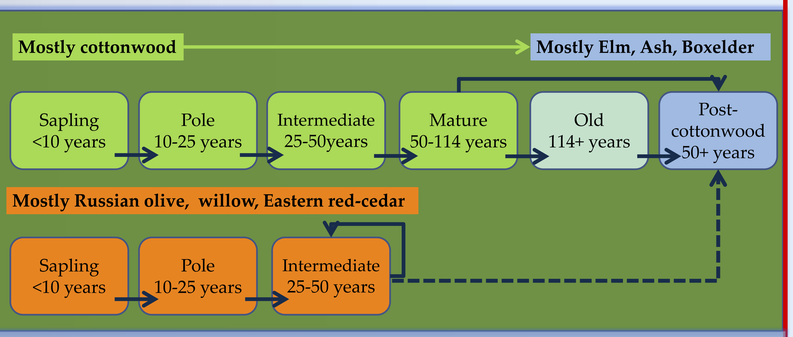

Figure 2: Pathway of succession of different forest types. Solid arrows indicate direction of succession. Dashed arrows are possible alternative routes.

Methods:

- The study site consists of two (39-mile and 59-mile) segments of remnant floodplain forest along the Missouri National Recreational River (MNRR) in southeastern South Dakota and northeastern Nebraska (**Figure 1**).
- Survey points are located in forest patches stratified by stand types and ages (**Figure 2**). 77 stands were sampled, with 2 points per stand. Stands less than 10 years old were not surveyed for birds .
- We conducted point-count surveys over four breeding seasons: pre-flood (2009-2010) and post-flood (2012-2013). Only pre-flood density estimates were used in modeling.
- Bird density estimates were generated using Program DISTANCE.
- Future forest area and bird abundance on the 39-mile segment were projected using STELLA II® Modeling & Simulation Software.
  - No non-cottonwood forest stands over 50 years old were available for sampling, but were a required component of the model.
  - Simulations were run twice using two different starting land cover areas, one set from 2006 (pre-flood) and another from 2012 (post-flood). Transition probabilities were the same in each scenario, based on 1984-2006 land cover changes.
  - Bird densities of mature and old non-cottonwood were assigned in two ways: birds are using the habitat as they would an intermediate non-cottonwood, or as they would post-cottonwood. See **Figures 6-9.**

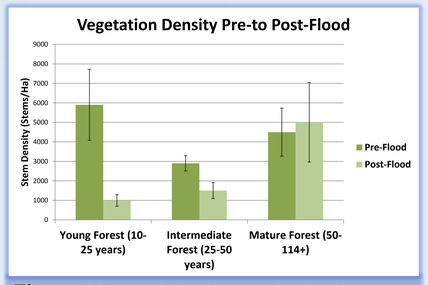

Figure 3: Tree and shrub stem density changes from pre- to post-flood. Average density of stems (+/- SE).

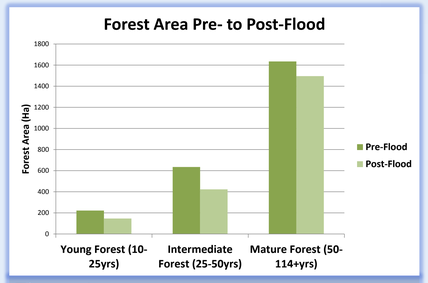

Figure 4: Change in forest area pre-flood to post-flood.

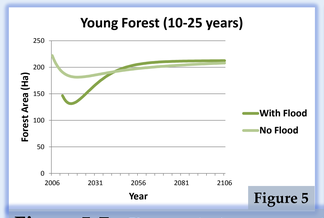

Figure 5

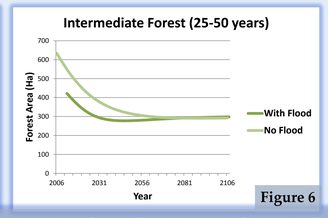

Figure 6

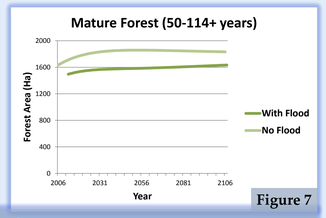

Figure 7

Figure 5-7: Changes in forest area with and without the effects of the 2011 flood.

	CW 10-25	CW 25-50	CW 50-114	CW 114+	PCW 50+	NCW 10-25	NCW 25-50
Bell's Vireo	1.29 (1.08-1.54)	0.26 (0.22-0.304)	0	0.0541 (0.046-0.0635)	0.0160 (0.0137-0.0187)	1.24 (1.02-1.52)	1.41 (1.14-1.73)
Willow Flycatcher	1.53 (1.32-1.77)	0.75 (0.647-0.867)	0.031 (0.027-0.0359)	0.058 (0.0501-0.663)	0.07 (0.0591-0.0784)	1.65 (1.31-2.08)	1.12 (0.942-1.320)
Red-headed Woodpecker	0.0555 (0.0496-0.0617)	0.1623 (0.144-0.182)	0.54 (0.474-0.612)	0.53 (0.472-0.604)	0.35 (0.306-0.392)	0.0545 (0.049-0.0611)	0.13 (0.111-0.144)
Baltimore Oriole	1.09 (0.971-1.22)	2.15 (1.88-2.46)	2.05 (1.78-2.37)	1.84 (1.61 -1.54)	1.44 (1.26-1.63)	0.46 (0.39-0.548)	1.21 (0.974-1.491)

Table 1: Bird densities (birds/ha) by forest type (CW=cottonwood, NCW=non-cottonwood, PCW=post-cottonwood), and age category (10-25 yrs, 25-50 yrs, 50-114 yrs, 114+ yrs). 95% Confidence Intervals are in parentheses.

Young Forest Species

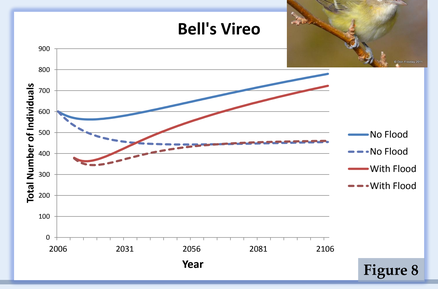

Figure 8

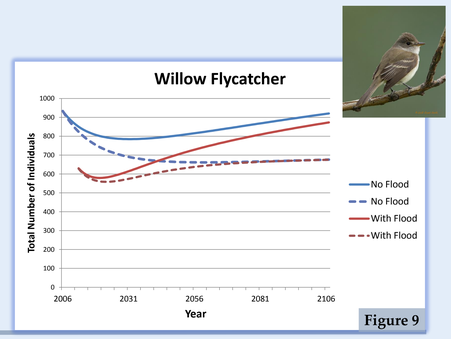

Figure 9

Mature Forest Species

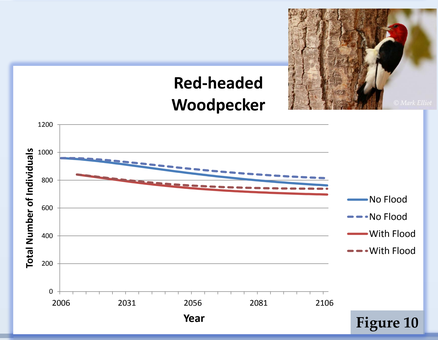

Figure 10

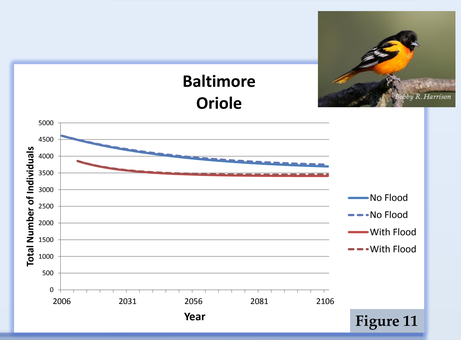

Figure 11

Figures 8-11: Projections of bird abundances, with and without the effects of the 2011 flood. **Solid lines:** Bird use of mature (>50 yrs) non-cottonwood as if it was *intermediate non-cottonwood*. **Dashed lines:** Bird use of mature non-cottonwood as if it was *post-cottonwood*.

Results and Discussion:

- Young and intermediate forests experienced flood related reductions of woody stem density. Mature forests, did not incur significant structural changes (**Figure 3**).
- Forest area was reduced among all forest type and age categories from pre-flood to post-flood (**Figure 4**). Young and intermediate forest loss is primarily attributed to flood effects. While unconfirmed, mature forest declines are thought to have been primarily due to greater than anticipated rates of agricultural clearing and losses from rising water tables around the Niobrara delta from 2006 to 2012.
- <u>Projected forest areas show:</u>
  - A rapid increase in **young forest** post-flood, exceeding "no-flood" projections by 2043. There is an approximate 5% gain in forest area by 2056 (**Figure 5**).
  - A general decline in **intermediate aged forest** among both scenarios, as they succeed to mature forest**.** Post-flood recruitment of forest adds a negligible amount (1%) of forest by 2076 over the no flood scenario (**Figure 6**).
  - Without the flooding, **mature forests** gain area from succession of intermediate forest, but then experience a long-term decline after 2054. With flooding, initial losses of forest are offset by recruitment, and there is a small, but steady increase of mature forest over time **(Figure 7)**.
- Bell's Vireo and Willow Flycatcher have highest densities in young and intermediate forests. Red-headed Woodpeckers and Baltimore Orioles have highest densities in mature forests (**Table 1**).
- <u>Projected bird abundances show:</u>
  - With the effects of flooding, abundances of all species will be less than or similar to the "no flood" projections.
  - Increase in abundance **of Bell's Vireo** and **Willow Flycatcher** if mature non-cottonwood forests are used. If mature non-cottonwood forest is not used, flood related recruitment of new forest would help boost abundances to the "no flood" level (**Figures 8 and 9**).
  - The steady decline in **Red-headed Woodpecker** abundances is reversed by flood related recruitment by 2113, *only* if they use mature non-cottonwood forests as they would post-cottonwood (**Figure 10)**.
  - The steady decline in **Baltimore Oriole** abundances is reversed by flood related recruitment around 2087, regardless of how mature non-cottonwood forest is utilized (**Figure 11**).

Future Work:

- Vegetation data collected in each forest stand will be used to model bird density and habitat relationships.
- Incorporate various flooding scenarios into STELLA models to determine what effect they might have on future bird abundances.
- Run simulations for the 59-mile segment.
- Determine habitat use and bird density estimates for mature non-cottonwood forest.

Literature Cited:

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