Notes S2 – Guiding hypotheses

I. Reproductive modification under intensive forest management

Overarching hypothesis*: Intensive forest management in the absence of GE strongly influences tree reproduction plantations*

A. Seed and/or pollen production decreases with increasing stand density and intensity of other silvicultural methods in forest plantations
B. Onset of reproduction is delayed with increasing stand density and intensity of other silvicultural methods in forest plantations
C. Genetic selection for rapid vegetative growth decreases reproductive onset and output in clonally propagated species
D. Genetic selection for rapid vegetative growth increases reproductive onset and output in the absence of clonal propagation

II. Local effects of GE reproductive modification on biodiversity

Overarching hypothesis*: The application of genetically engineered reproductive modification influences stand-level (alpha) biodiversity*

A. Reproductive structures (i.e., catkins, cones, and flowers) and products (i.e., pollen, seed, and nectar) of focal tree genera provide habitat features (i.e., food, shelter, or breeding structures) for organisms
B. Endangered and/or threatened species will be affected by GE tree reproductive modification
C. GE tree reproductive modification will alter species interactions (specifically propagule dispersal and/or pollination mutualisms, but also competition, predation, parasitism, mutualism, and a-/commensalism)
D. Tree reproductive structures/products provide important nutritional supplements for organisms that support growth and reproduction (e.g., protein)
E. Pollen-less, male-sterile anthers and/or Seed-less, female-sterile ovaries have decreased nutritional value for organisms

F. GE tree reproductive modification will alter tree allocation of resources to defensive compounds, potentially altering the nutrition of vegetative tissues for wildlife
G. Due to their episodic nature, few species specialize on tree reproductive structures and/or products
H. Production of inviable, but otherwise nutritively normal, pollen, nectar and/or fruit/seeds will have little impact on biodiversity
I. GE tree reproductive modification will influence nutrient cycling
J. GE tree reproductive modification will alter the abundance and diversity of soil organisms (i.e., mycorrhizae and microbes such as bacteria)
K. Removal or reduction of pollen will have lesser impact on biodiversity in ecosystems in which wind-pollinated trees are the dominant genera compared to ecosystems in which insect-pollinated trees are the dominant genera

L. Removal or reduction of fruits and seeds will have little impact on biodiversity in small seeded species whose seeds have short viability periods (e.g., *Populus, Salix, Eucalyptus*) compared to that in large-seeded species with persistent seeds (e.g., *Pinus*)

III. Landscape-level effects of GE reproductive modification on biodiversity

Overarching hypothesis*: The application of genetically engineered reproductive modification in plantations influences landscape-level (beta) biodiversity*

A. The scale at which genetically engineered reproductive modification occurs will influence the strength of its impacts on organisms and ecological processes
B. GE reproductive modification will alter species interactions (specifically propagule dispersal and/or pollination mutualisms, but possibly also competition, predation, parasitism, mutualism, and commensalism)
C. Endangered and/or threatened species will be influenced by GE tree reproductive modification
D. GE tree reproductive modification will affect nutrient cycling
E. GE tree reproductive modification will affect nutrient inputs to freshwater ecosystems

F. Removal or reduction of pollen will alter local and regional climates by decreasing cloud condensation
G. GE tree reproductive modification will negatively affect the exchange of genetic material in native relatives of focal tree genera across landscapes

IV. Comparative impacts of reproductive modification on biodiversity

Overarching hypothesis*: The application of GE reproductive modification in forest plantations will have a proportionally small (e.g., <10%) impact on biodiversity compared to the conversion of wild forests to plantations or the conversion of stands of native tree taxa to exotic tree taxa*

V. Management actions that may mitigate direct impacts of GE tree reproductive modification on biodiversity

Overarching hypothesis*: The direct impacts of reproductive modification on biodiversity can be mitigated by stand and landscape management (e.g, limiting planting, creating corridors, and enlarging wild/managed refugia within plantation landscapes)*

VI. GE reproductive modification and social considerations

Overarching hypothesis*: The application of GE reproductive modification plantations will be socially complex and contentious*

A. Given its highly technical nature and novelty, the public is likely unaware of, and therefore unknowledgeable about, flowering modification of forest trees
B. Low knowledge and awareness by the public suggests social trust (e.g., in managers / experts), and general social norms will be responsible for attitudes toward tree reproductive technologies
C. Pubic responses will follow typical risk perception dimensions, including newness/unknown (i.e., new technology), dread (i.e., negative association with GMOs and human health effects even if unfounded), concern of ill effects of tampering with nature (e.g., potential effects on pollinators), and an ethical preference for the natural
D. The public will likely not differentiate perceptions of flowering modification in forest trees from other well-known GM uses (e.g., GMOs in food production).
E. The public will exhibit stronger negative reactions to GE modification of reproduction compared to other tree traits subject to GE (e.g., pest-resistance and decreased lignin)

F. Cognitions / perceptions will vary between experts and the public (e.g., experts will have lower perceived risks, higher perceived benefits, more positive attitudes, higher acceptance of use).
G. Persuasion theory / models (e.g., Elaboration Likelihood Model, Heuristic—Systematic) are tools that could be used in information campaigns and political / ideological battles for changing attitudes.
H. Given technical nature of topic, persuasion will target heuristic / peripheral cues that focus on message source (e.g., celebrity, politician, scientist / expert), use of imagery, and emphasis on highly emotional information (e.g., risks / dangers).
I. Persuasion attempts are likely to be unsuccessful due to nature of controversial issues being tied to base values / value orientations (i.e., difficult to change).
J. Anti-GMO groups will use GE reproductive modification in trees as a tool to exacerbate negative public sentiments regarding plantation forestry and GE trees generally (including its common corporate ownership structure).
K. Protection of wild forests from perceived contamination from GE trees will be viewed as responsible stewardship in the establishment of GE and exotic tree plantations. This perception will be strongest when exotic species have weedy or invasive qualities, or when GE trees have compatible wild relatives are employed.
L. Mitigating the ecological effects of GE reproductive modification in trees through landscape management will be viewed positively if accompanied by government (e.g., Forest Practice Act) or NGO (e.g., FSC certification) recognition.
M. Independent forestry certification will help ensure landscapes with GE modified (reproductive and/or otherwise) trees are used responsibly (i.e., to mitigate negative impacts on biodiversity).