

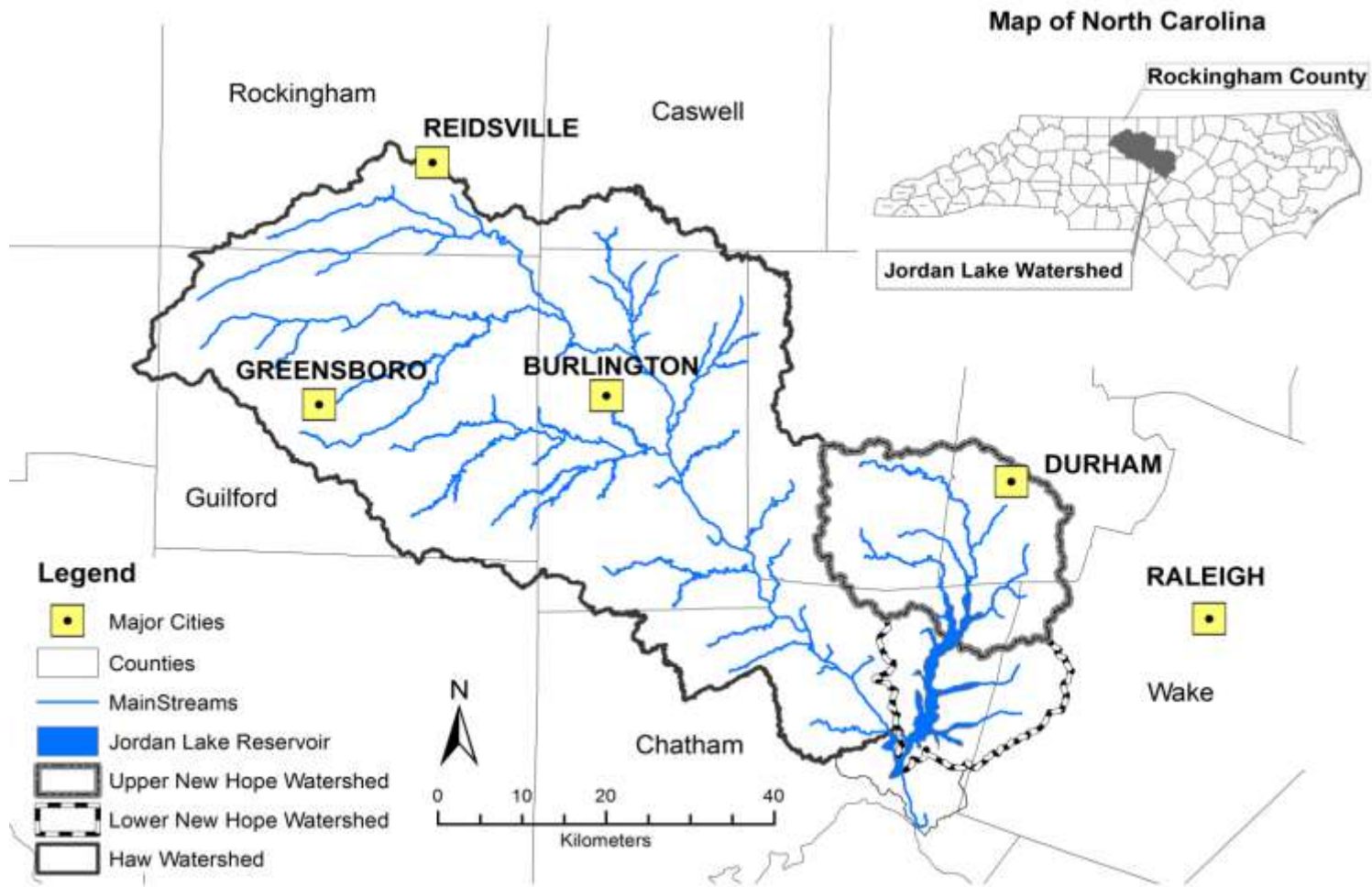
Impact of relative demand for ecosystem services on their stacking markets

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In the United States, 60 percent of assessed lakes, reservoirs, and ponds are threatened or impaired by nutrients (Selman, et al. 2009).





Jordan Lake Watershed, North Carolina

Water Quality Trading Program (WQT)



Nutrient Reduction at Lower Cost



Best Management Practices

Waste Water Treatment Plants



- Design an ecosystem services stacking for Jordan Lake Watershed.
- Investigate the role of relative ecosystem services demand on stacking condition.

Credit stacking

1-Horizontal credit stacking

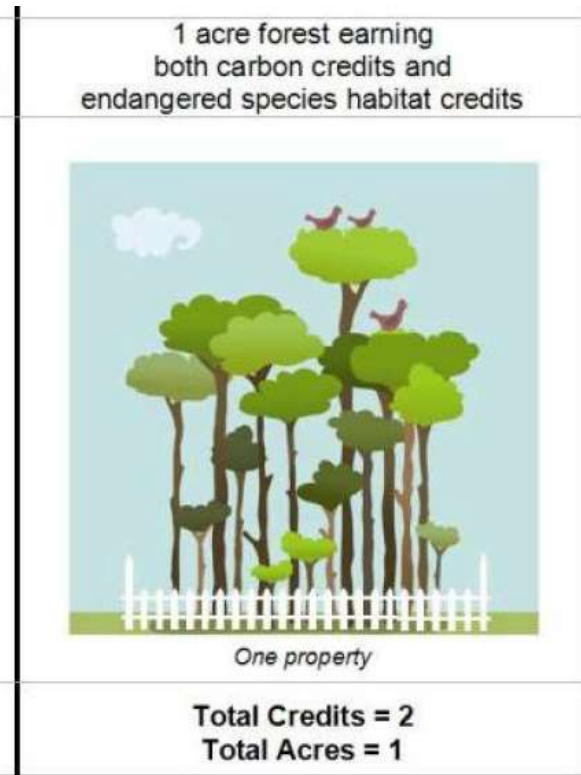
2-Vertical credit stacking

3-Temporal credit stacking

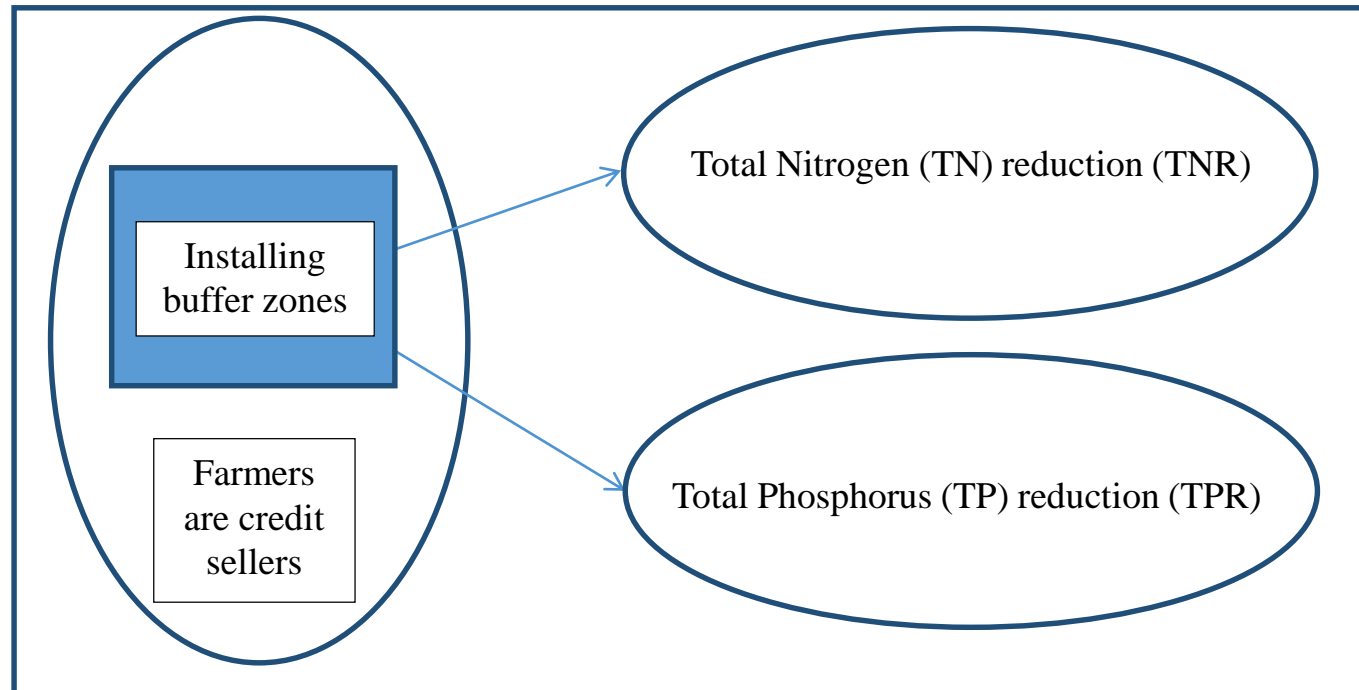
Horizontal



Vertical



Vertical Stacking

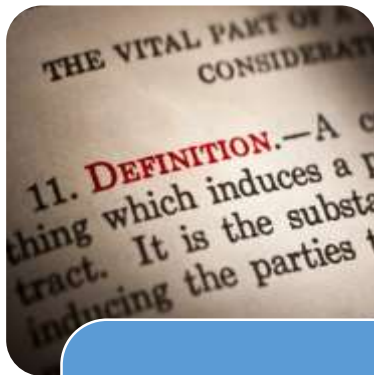


Vertical stacking

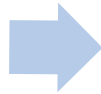
A farmer can maximize his/her profit (π) by selling crops, TN credits, and TP credits.

For simplicity, TNR and TPR are referred to as ecosystem services here because total nitrogen (TN) and total phosphorus (TP) reductions improve ecosystem services that better human wellbeing.

- Electric Power Research Institute (EPRI, 2011) survey showed 70% of the respondents believed that stacking increases the financial value of the conservation projects.



EPRI (2011) survey showed 83% of the respondents agreed that the best definition for stacking is **vertical stacking**.



Vertical Stacking is **challenging** because of **double dipping** (Fox et al., 2011).



Double Dipping: “additional payments do not result in additionality” (White and Penelope, 2013; Robertson et al., 2013; Ott 2010; Cooley & Olander 2011).

A close-up photograph of a person's hands, wearing a blue and white striped shirt, holding a large glass jar. The jar is filled with US dollar bills, and the person appears to be pouring or holding the money. The background is a plain, light-colored surface.

Double-dipping occurred in North Carolina.

Wetland and stream ecosystem services were first defined and sold as wetland credits and then a decade later, again in a separate market as water-quality improvement credits, despite a lack of additional improvements in the meantime (Program Evaluation Division, 2009; Kane, 2009).

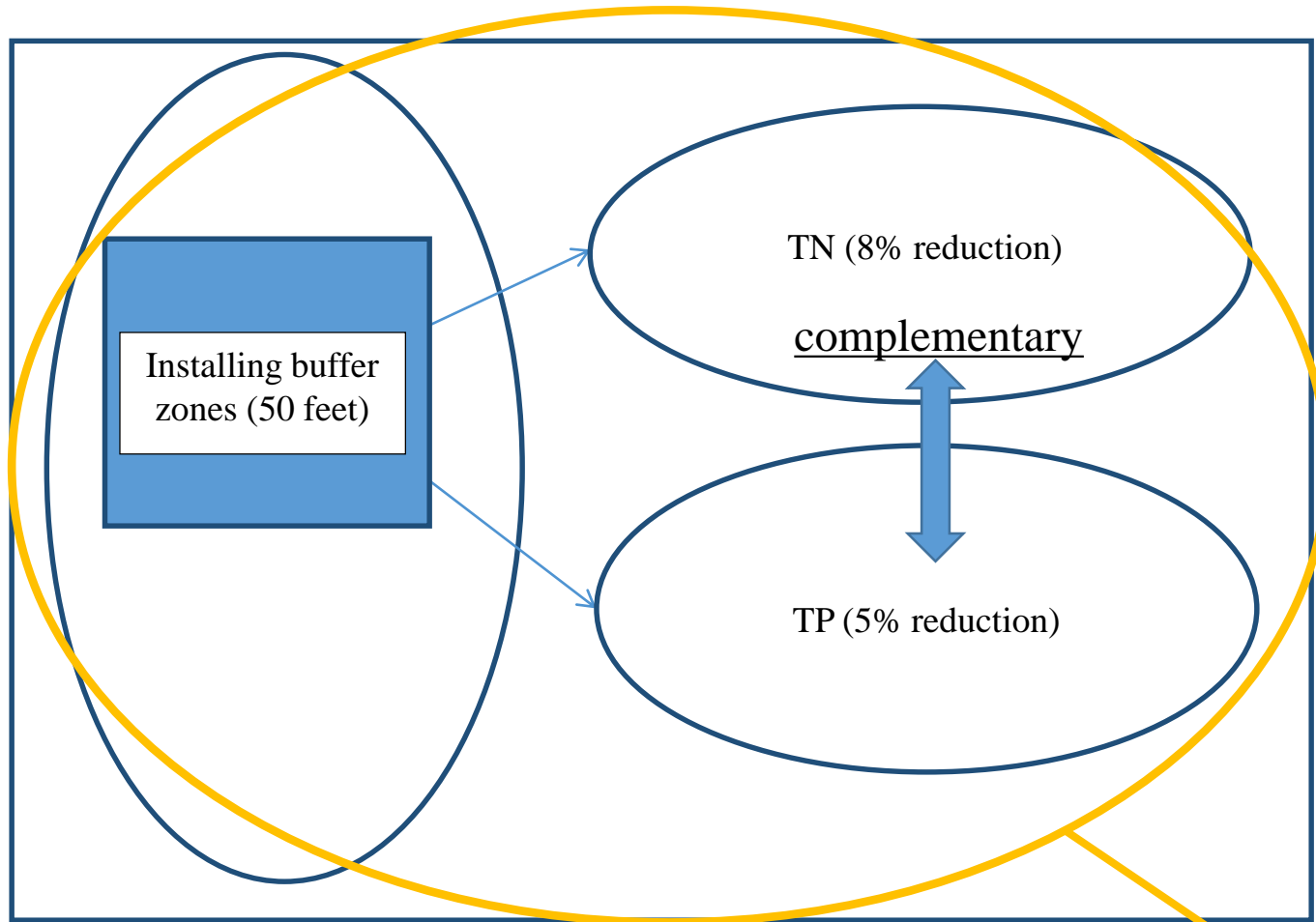
The image features three large, thick-outlined geometric shapes that overlap each other. On the left is a blue square, rotated slightly counter-clockwise. In the center is a green circle. On the right is an orange triangle, rotated slightly clockwise. The shapes are arranged such that the green circle overlaps the blue square and the orange triangle, and the blue square and orange triangle also overlap each other. The word "Methodology" is centered over the intersection of these shapes.

Methodology

Credit Stacking in Jordan Lake, NC

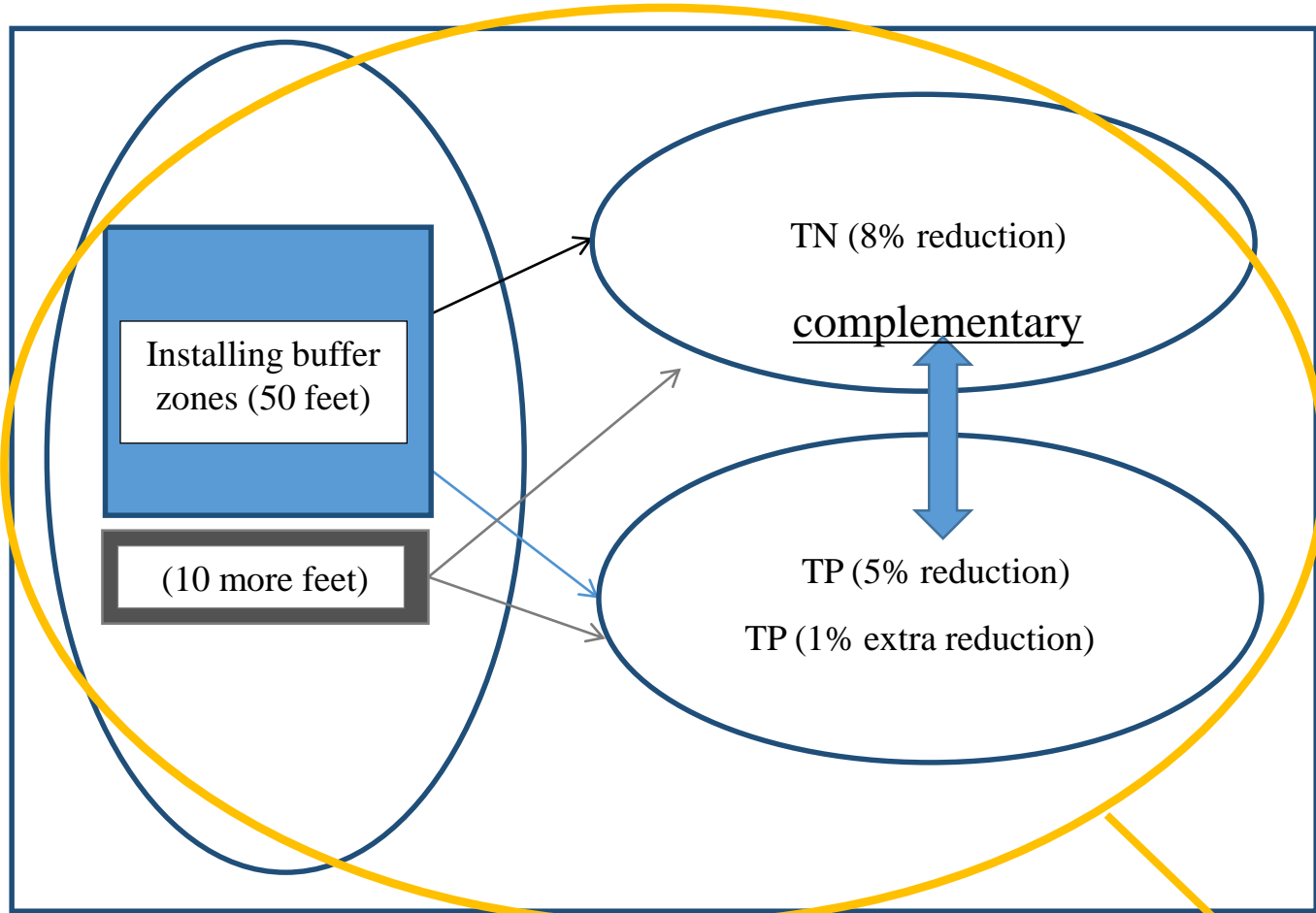
- A hypothetical vertical ecosystem services (ESs) stacking scenario is developed for (WQT) program in North Carolina.
- TNR and TPR are complementary services produced by the single practice of riparian buffers.
- TNR is the primary service that already has a market in the form of a WQT program.
- TPR is a hypothetical, secondary service that we introduce to determine when its demand, relative to TNR demand, creates appropriate incentives for ecosystem stacking.
- TNR and TPR demands are linear functions of credit prices.

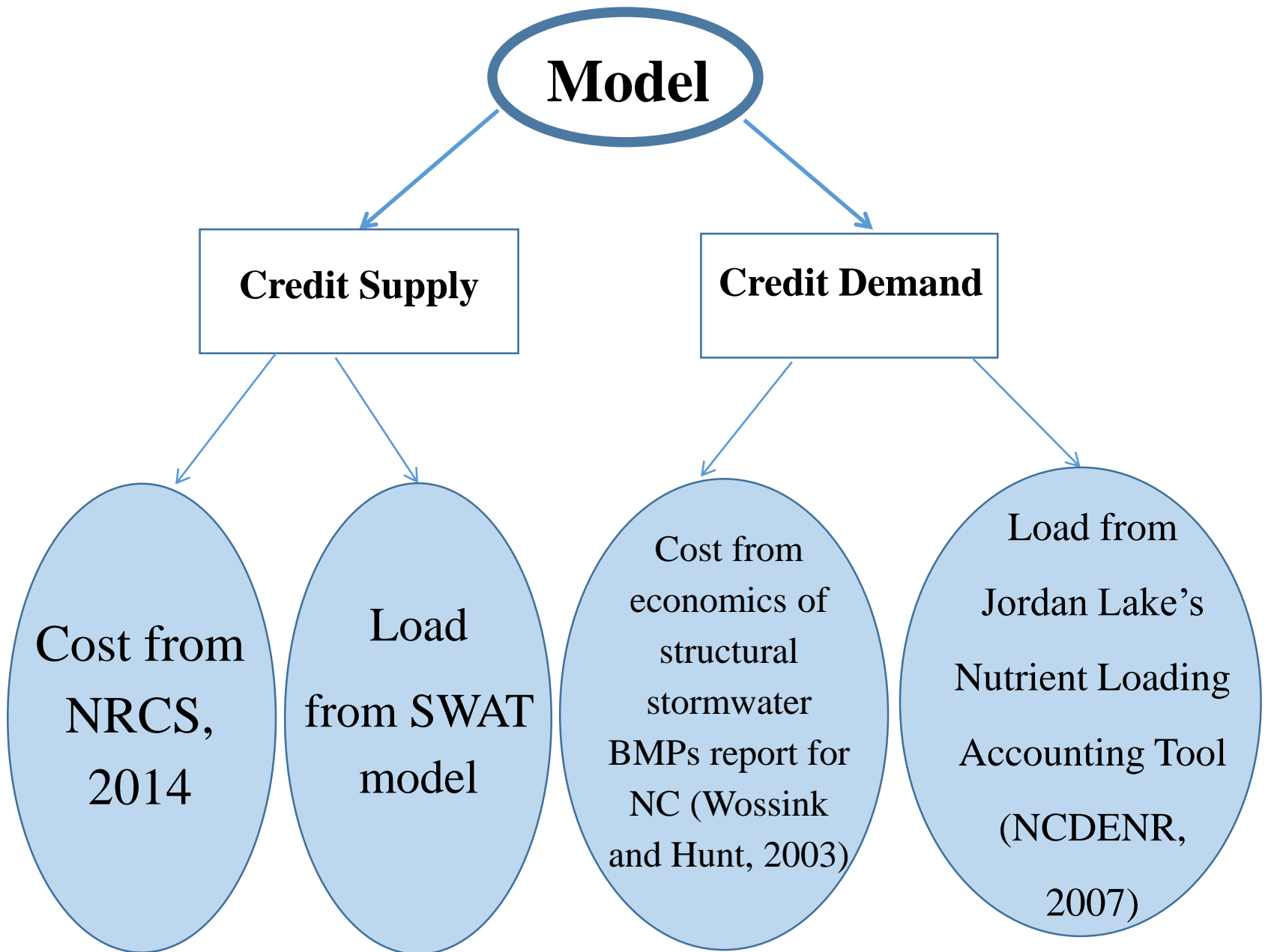
Double-dipping



Double-dipping
12

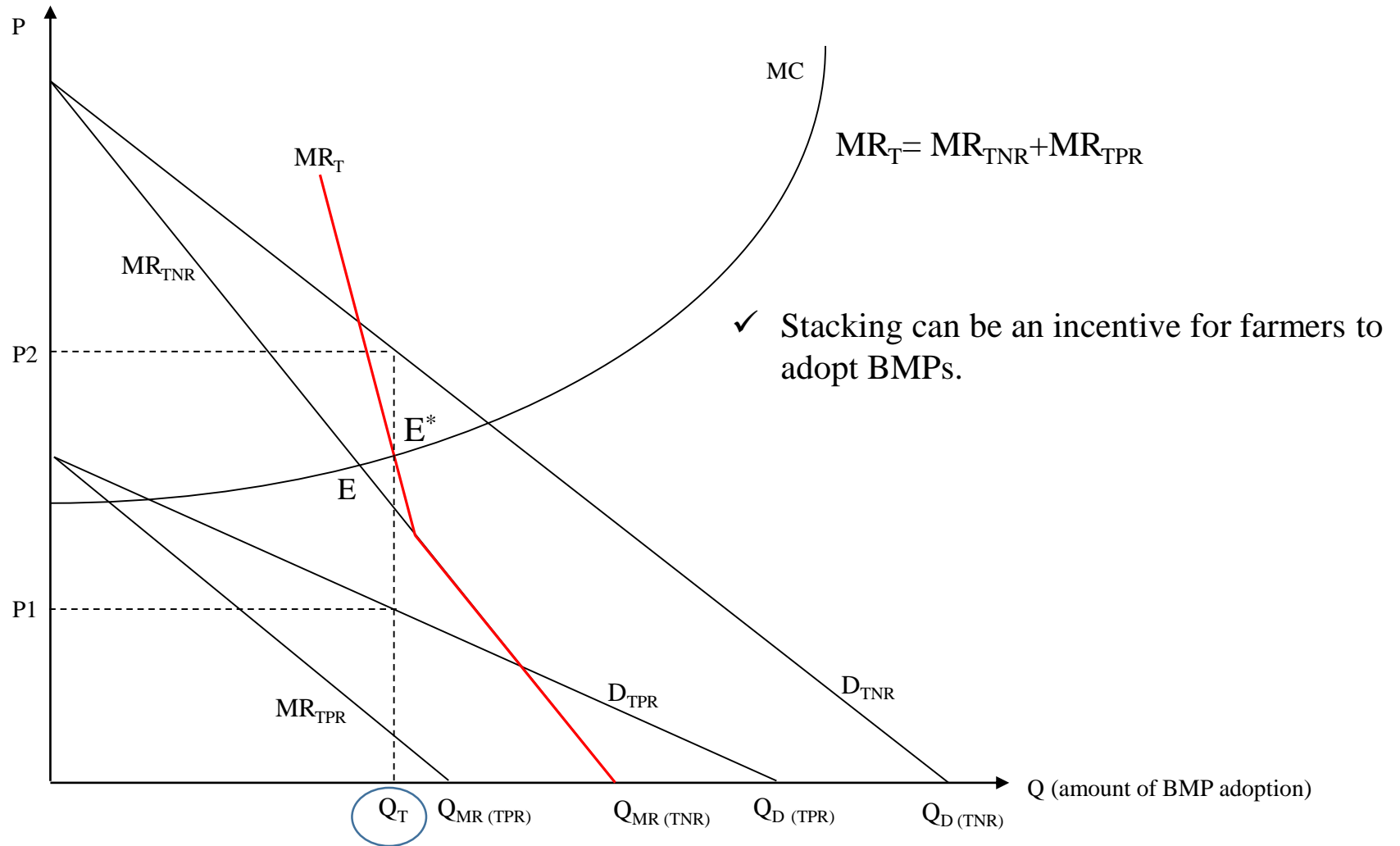
Stacking





Jordan Lake WQT Program Model

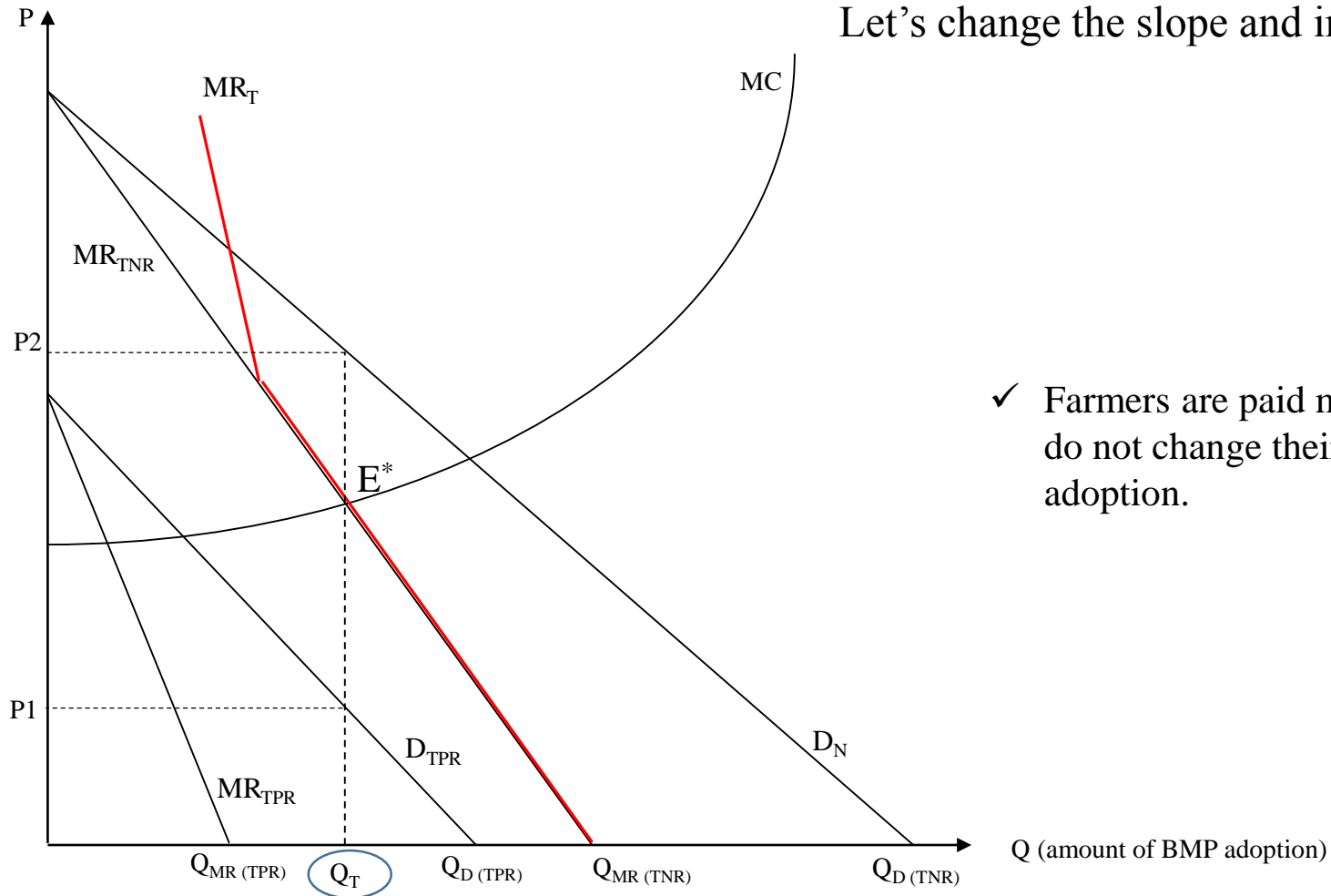
Sufficient



MR: Marginal revenue

MC: Marginal cost

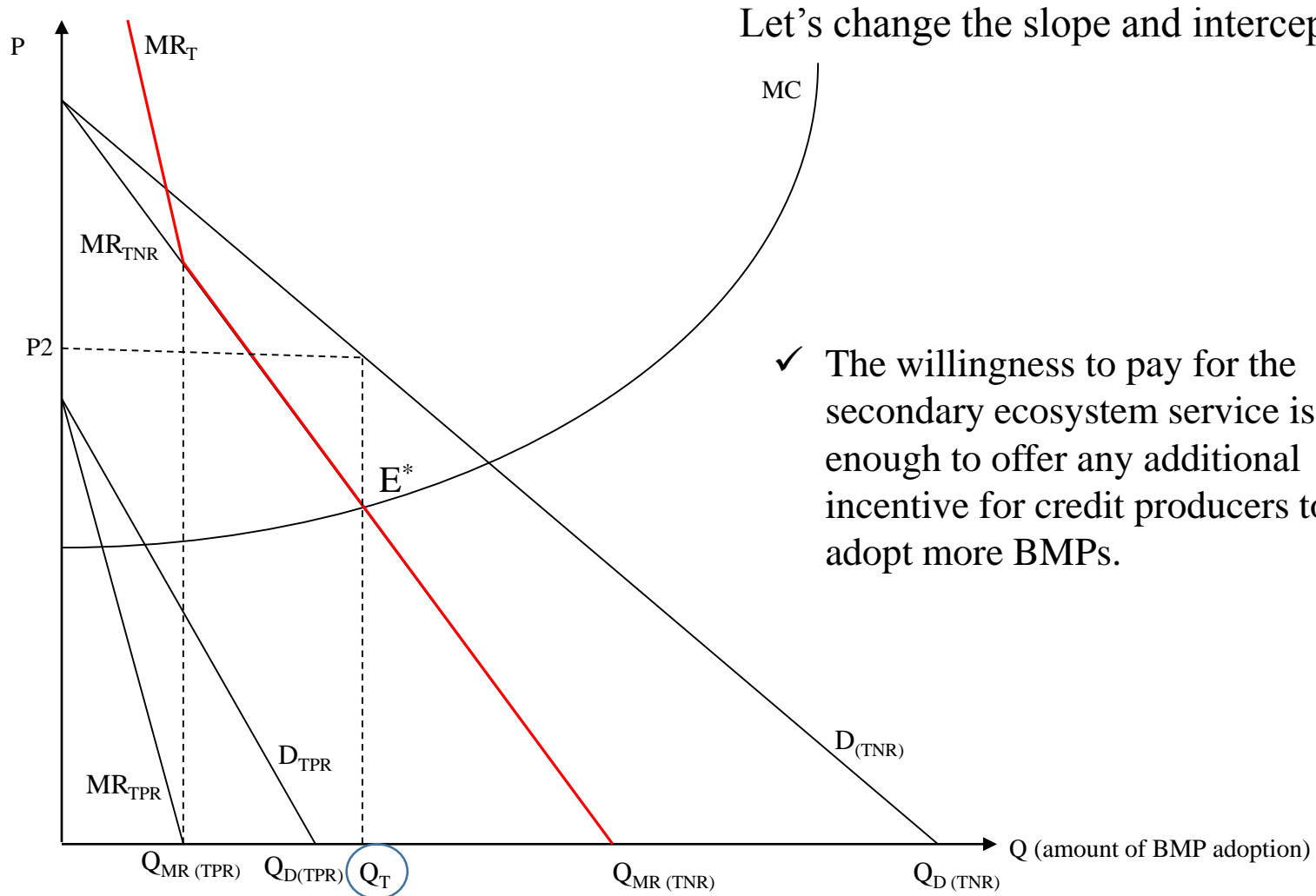
Double Dipping



MR: Marginal revenue

MC: Marginal cost

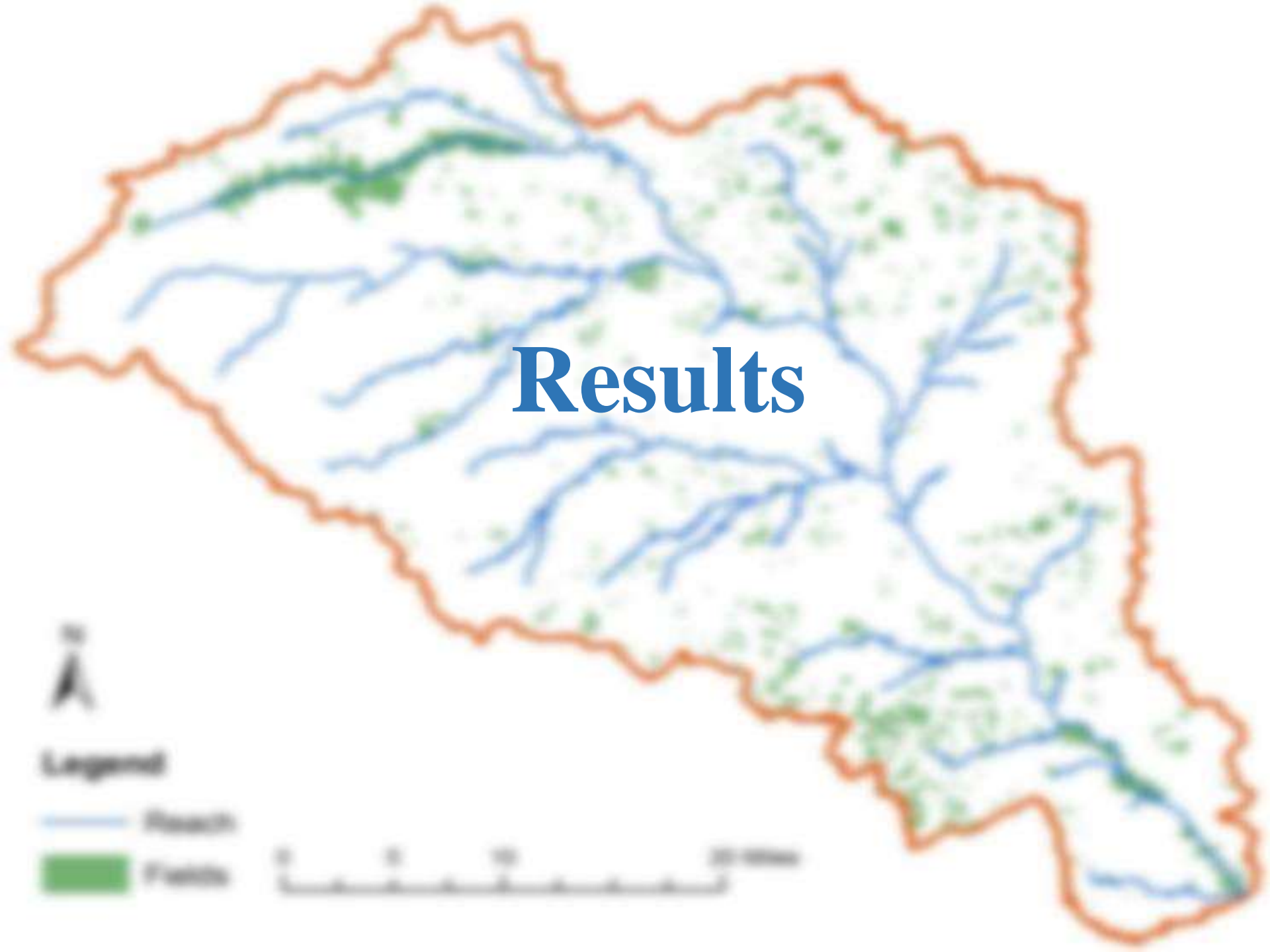
Insufficient



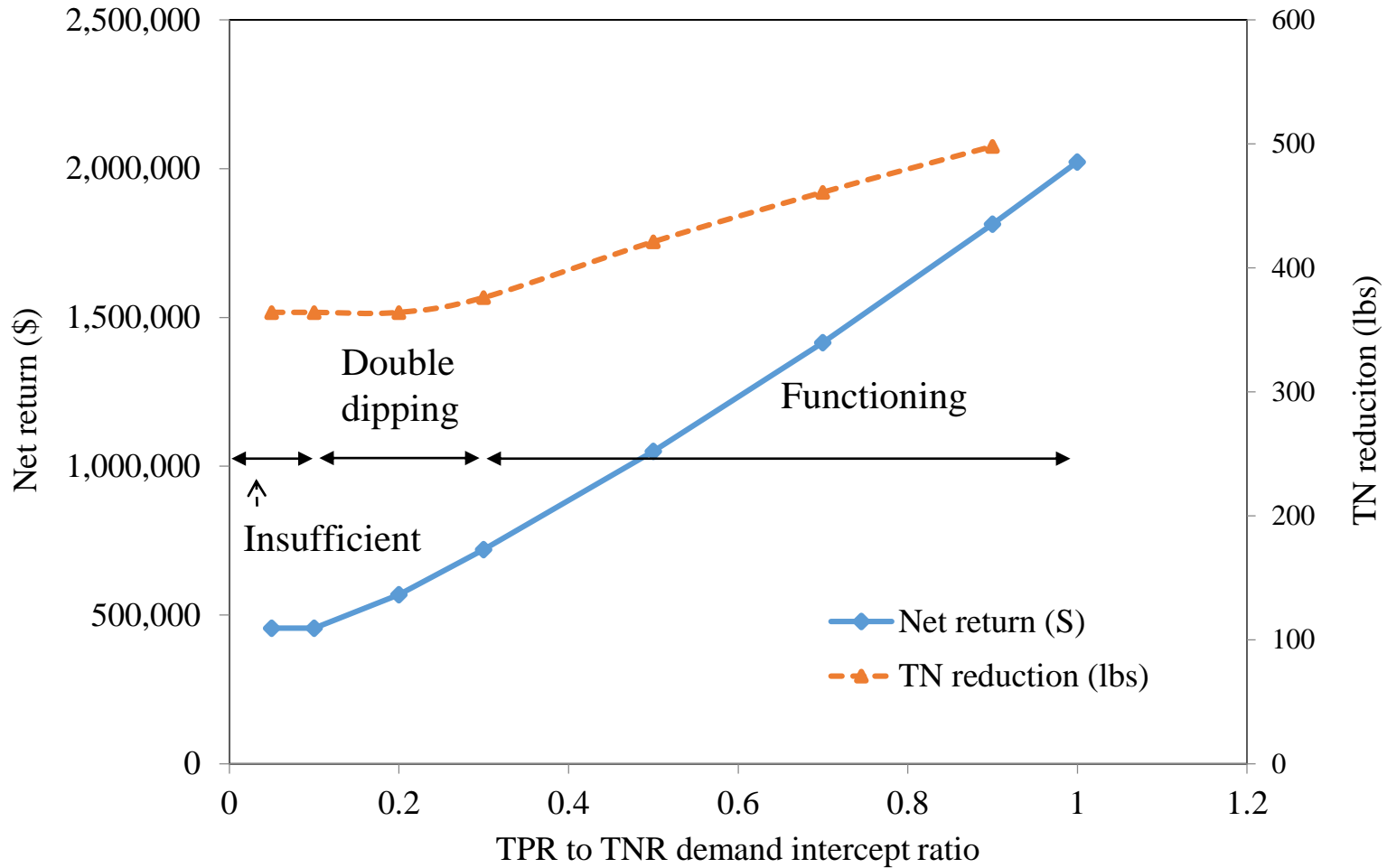
MR: Marginal revenue

MC: Marginal cost

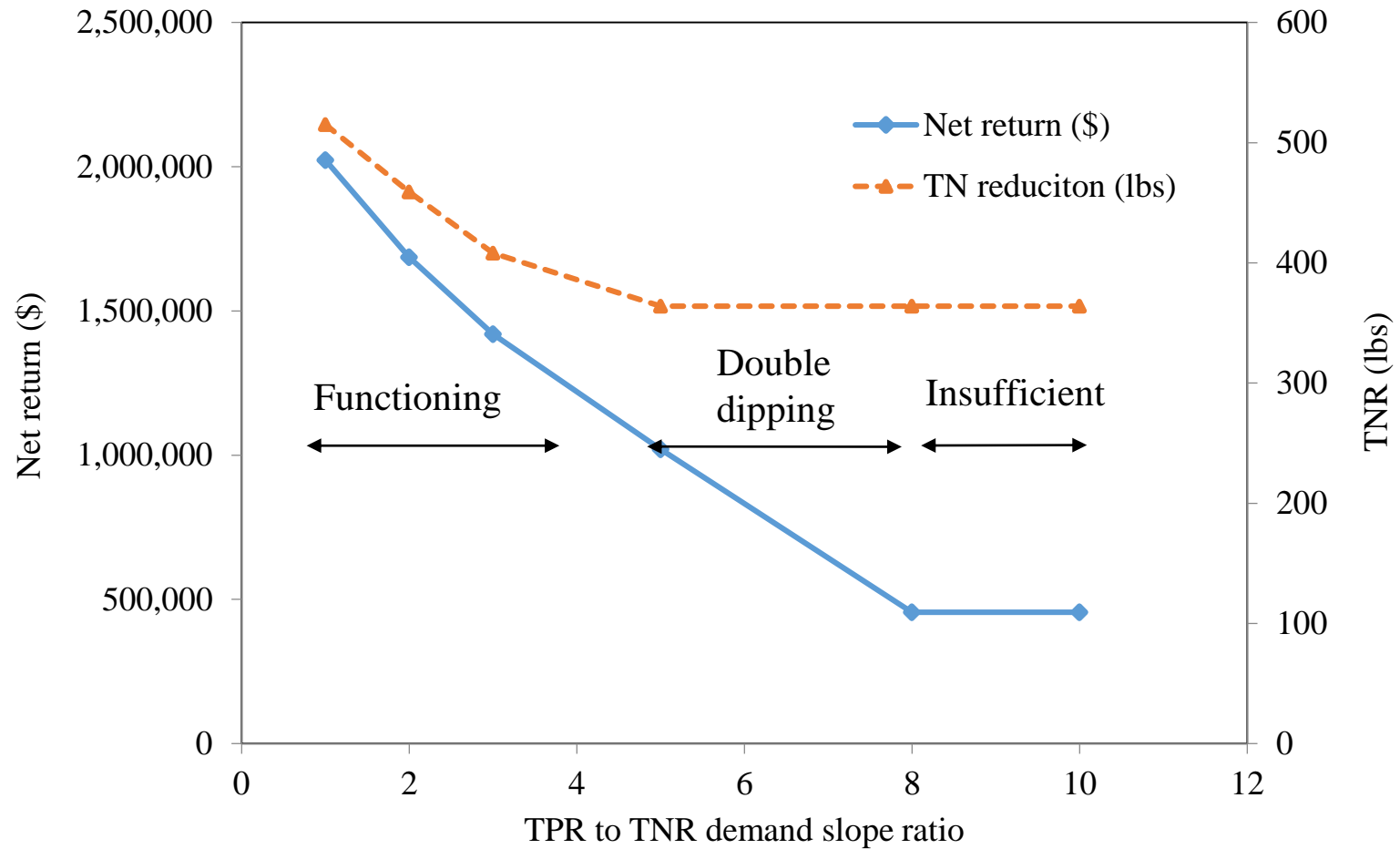
Results



Role of relative demand intercept for two ESs



Role of relative demand slope for two ESs



Conclusion

- Ecosystem services credit stacking is a motivating tool, because stacking diversifies the sources of revenues and decreases the risk of cooperating with a program (Olander, 2011).
- We were able to apply a realistic and measurable stacking program to the emerging WQT program in Jordan Lake watershed, NC.
- Based on the analysis, relative services' demands plays profound role on ecosystem service stacking strategies.

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Thank you.
Any Questions?

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