STAYING CONNECTED IN THE FACE OF CLIMATE CHANGE

A modeling, visualization, and design toolkit for climate refugia & wildlife corridors to inform adaptation planning and land management in the Golden Gate Biosphere.

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THESIS RESEARCH PLAN

- Abstract & Research Questions
- Theoretical Framework
- Site Description
- Case Study & Precedent Analysis
- Research Methods
- Resources

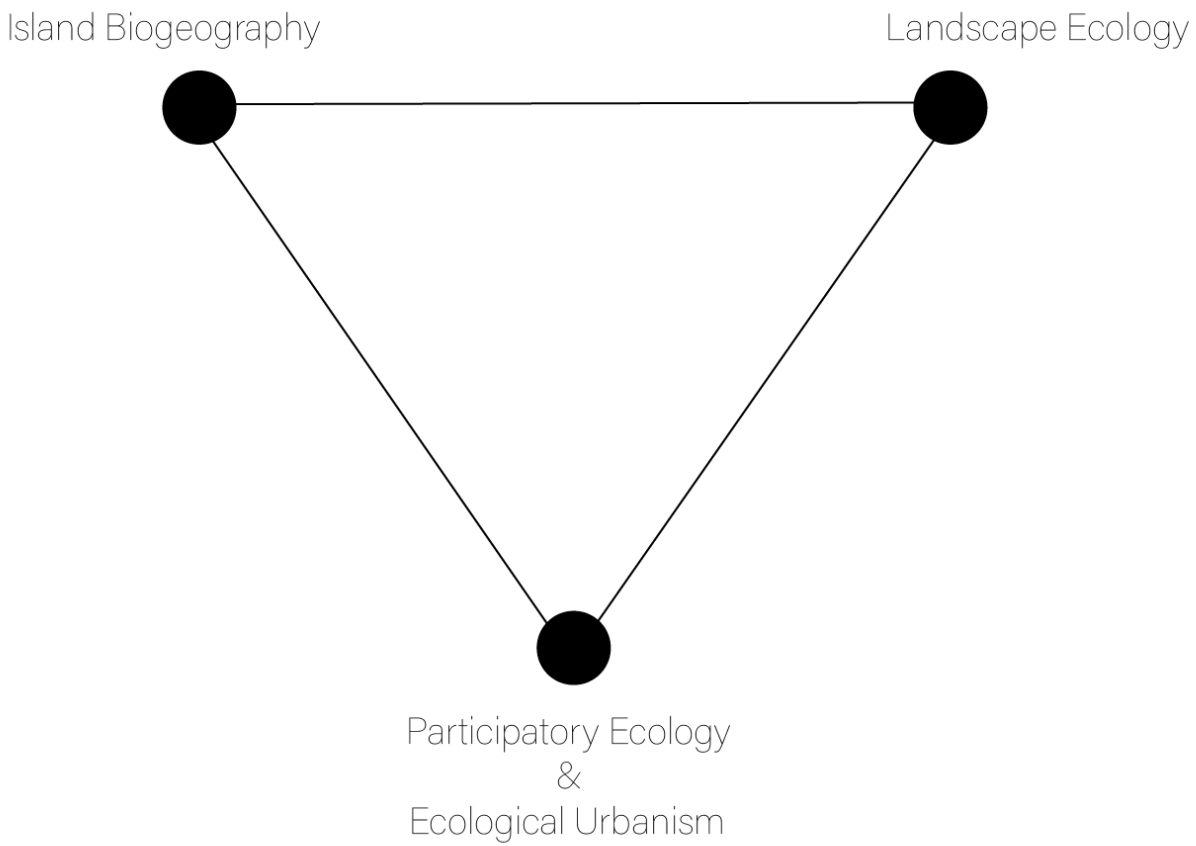
This research seeks to develop an analysis of landscape connectivity in the Golden Gate Biosphere across multiple target species.

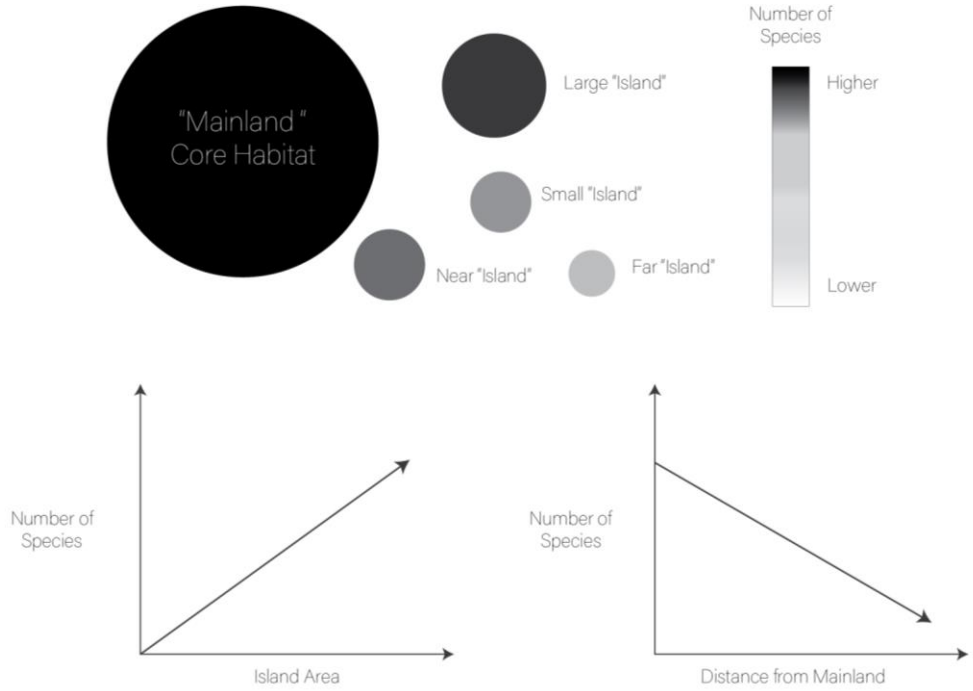
I. RESEARCH QUESTIONS

Considering multiple species in a heterogeneous landscape, where are potential climate corridors located for target species in the Golden Gate Biosphere?

- How do the results of varying connectivity analysis methods compare? Can these methods be used to better inform corridor locations?
- How might refugia and corridor adaptation strategies be visually depicted and modeled to communicate climate risks?
- How can this information be synthesized into a cohesive planning toolkit consisting of climate adaptation strategies and potential application methods?

II. THEORETICAL FRAMEWORK



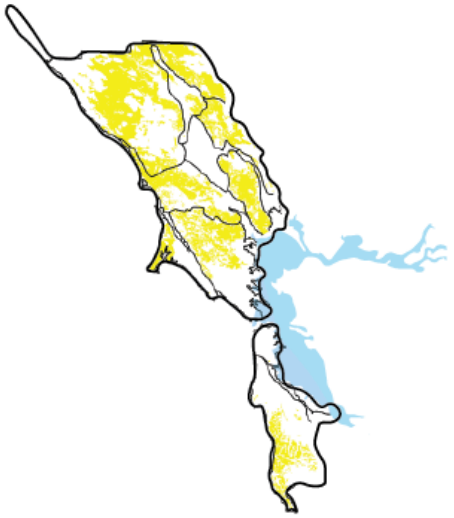


III. SITE ANALYSIS

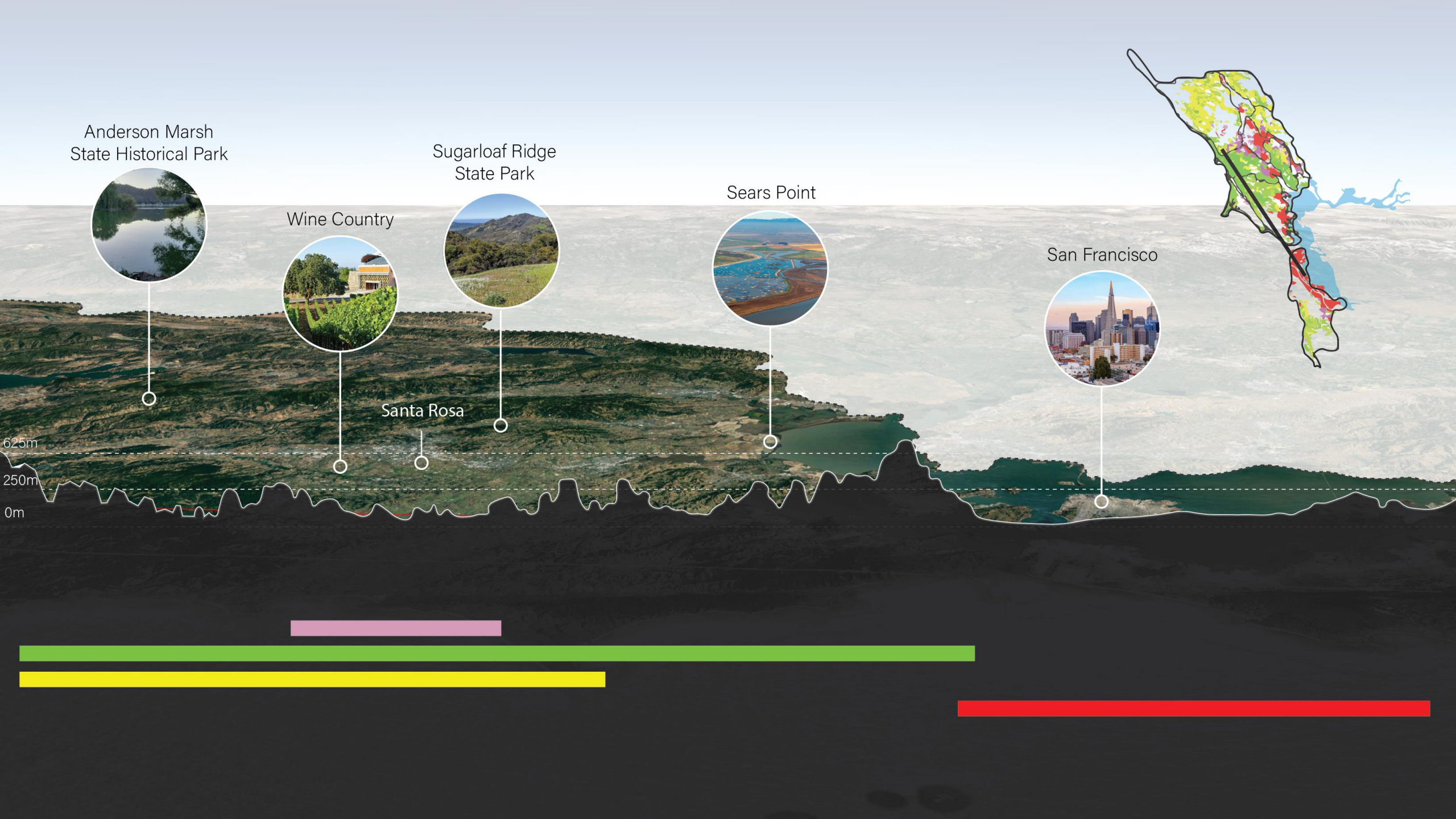
URBAN
177,762 acres

GRASSLANDS
346,334 acres

RURAL RESIDENTIAL
85,091 acres



GRAZING
562,103 acres


Anderson Marsh
State Historical Park
Wine Country
Sugarloaf Ridge
State Park
Sears Point
San Francisco
Santa Rosa
625m
250m
0m

MOUNTAIN LION

SAN BRUNO ELFIN BUTTERFLY

COHO & STEELHEAD

CALIFORNIA RED-LEGGED FROG

COMMON YELLOWTHROAT

SANDERLINGS

BRANDT'S CORMORANT

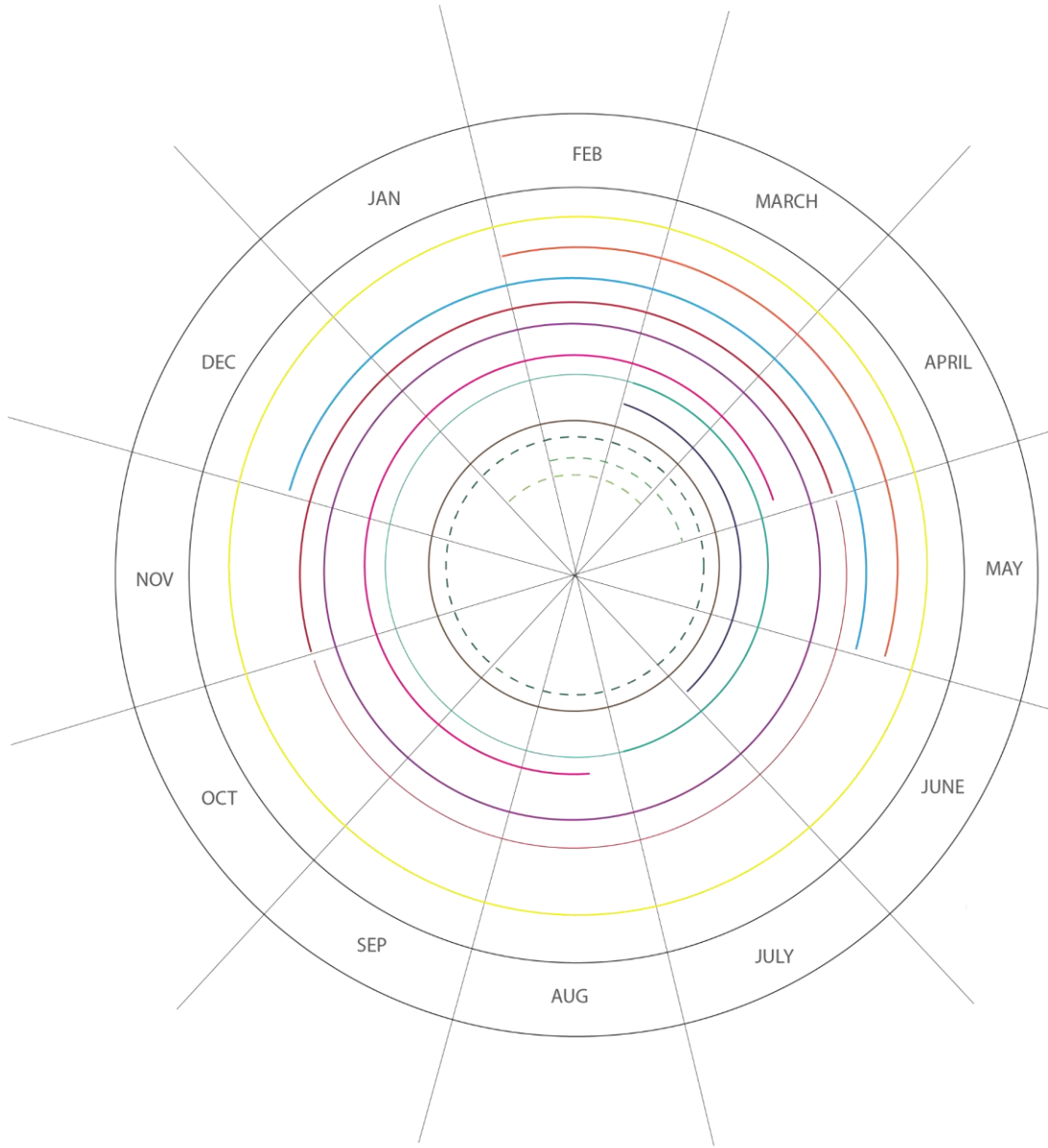
MISSION BLUE BUTTERFLY

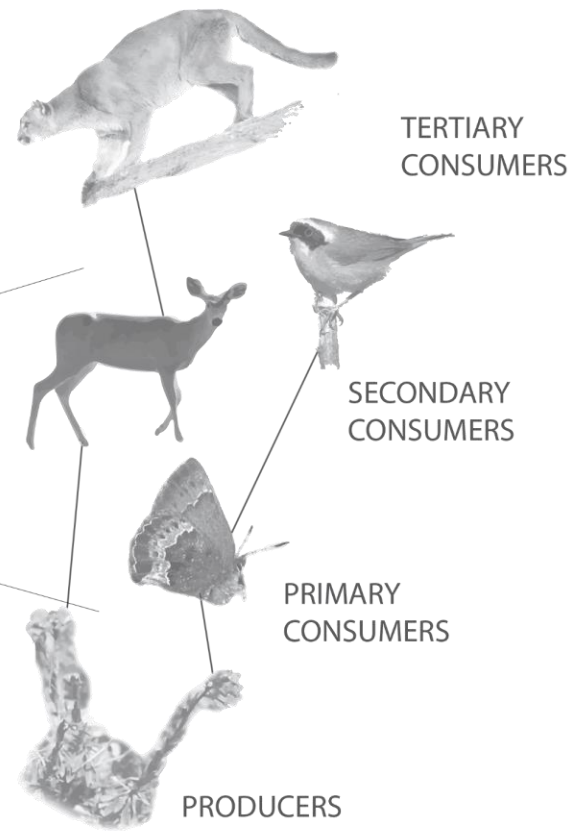
KINGFISHER

BLACK OAK

SERPENTINE PLANTS

WESTERN LEATHERWOOD





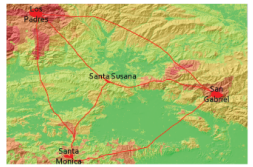
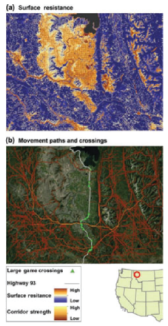
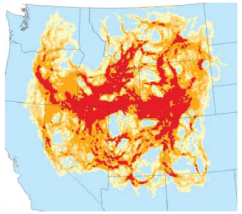
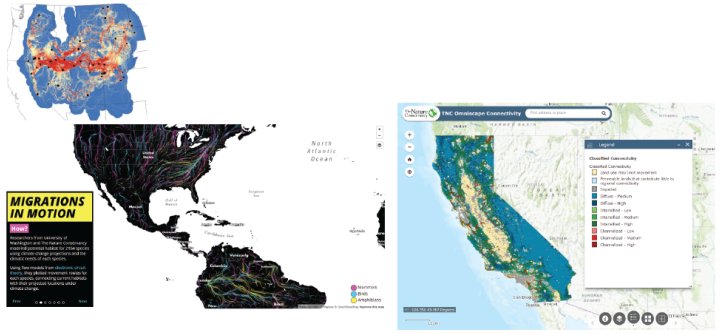
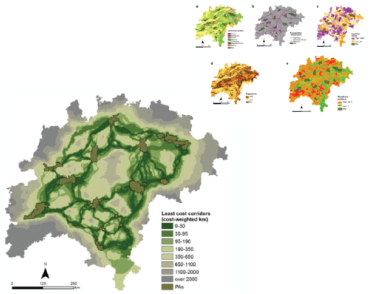
TERTIARY CONSUMERS

SECONDARY CONSUMERS

PRIMARY CONSUMERS

PRODUCERS

IV. CASE STUDY & PRECEDENT ANALYSIS

Tool / Toolkit	ARCGIS SPATIAL ANALYST	UNICOR	CONNECTIVITY ANALYSIS TOOLKIT (CAT)	CIRCUITSCAPE & OMNISCAPE	LINKAGE MAPPER
Method of Corridor Analysis	Cost-distance: Identifies path(s) that minimize total travel cost (cost-weighted distance) between source and destination.	Applies modified least cost path algorithm to all pairs of species' locations, combines to form density map.	Network Flow: Optimization problem identifying distribution of movement across landscape that maximizes flow of dispersers between source and destination.	Circuit Theory: Treats landscape as electrical circuit with probability of movement dependent on resistance; accounts for positive effect of path redundancy on connectivity. Circuitscape with a moving-window algorithm to quantify ecological flow (potential connectivity). The algorithm incorporates all possible pathways between movement sources and destinations and identifies areas of high flow via low-resistance routes.	Cost-distance modeling, circuit theory modeling, graph theory analysis, pinch-point and barrier analysis, climate gradient corridor analysis.
Limitations	Requires designation of source-destination pairs. Does not account for dispersal distance limitations or effects of path redundancy on connectivity.	Outputs network of (smoothed) paths, not continuous corridor surface. Often oversimplifies.	Computational intensity increases exponentially with number of cells. Requires designation of source-destination pairs. Does not account for dispersal distance limitations.	Computational intensity increases exponentially with number of cells. Requires designation of source-destination pairs. Does not account for dispersal distance limitations.	Does not account for dispersal distance limitations. *However, capability to use multiple methods of corridor analysis in combination with one another
Visualizations					

V. RESEARCH METHODS

A. Analysis

- Suitability analysis for core habitat
- LinkageMapper for corridor identification

B. Planning

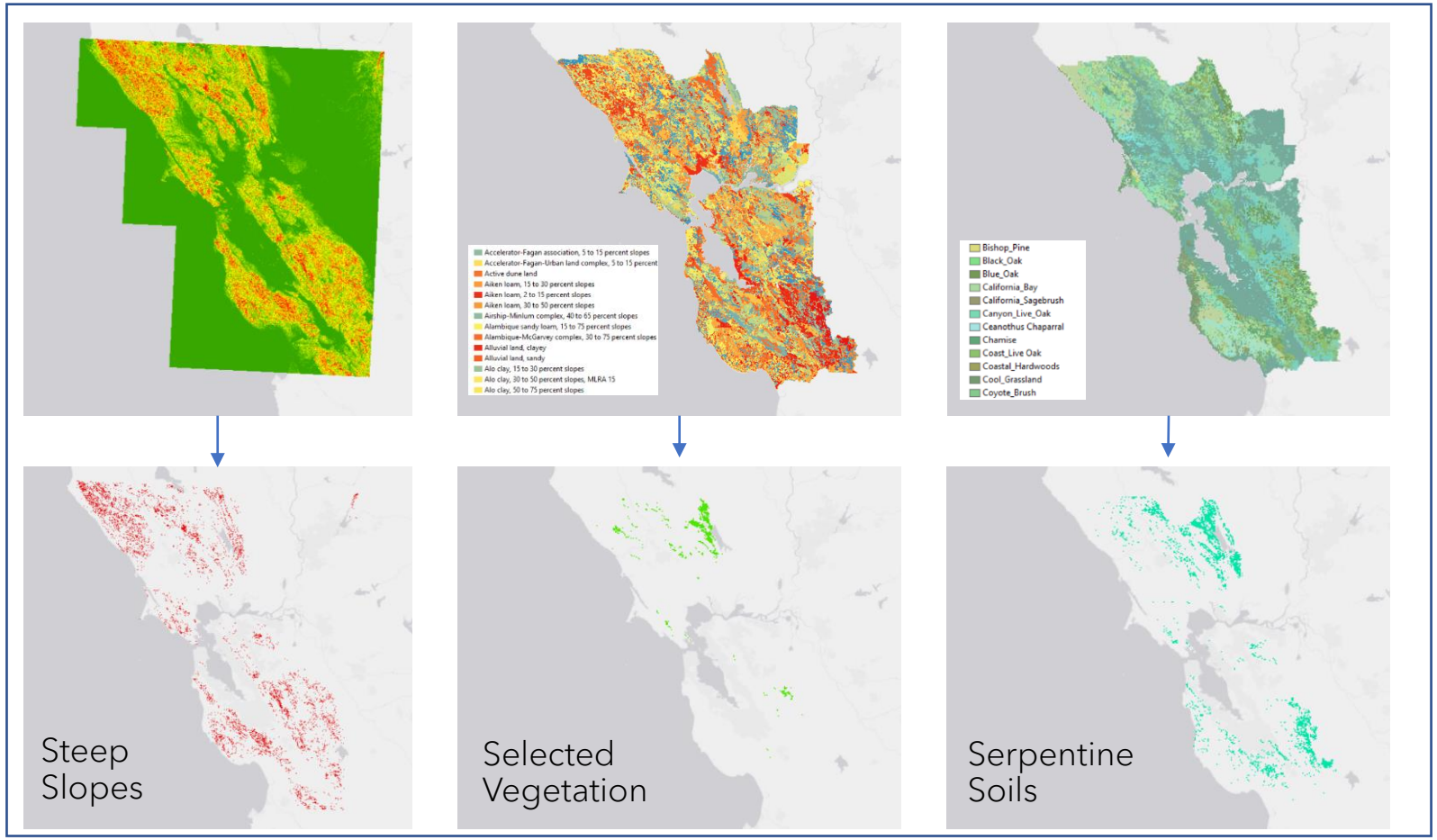
- Typologies of corridors and barriers

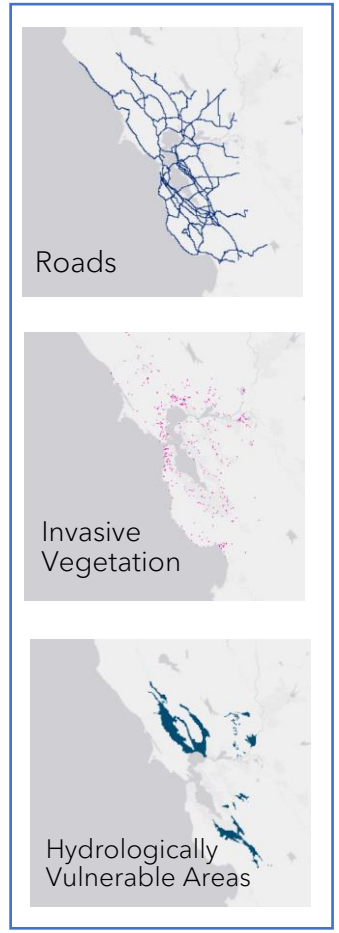
C. Design

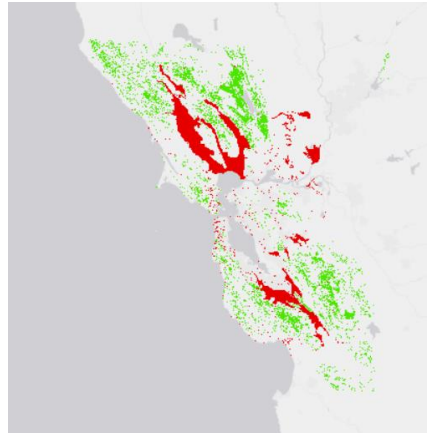
- Downscaled corridor design

A. SPATIAL ANALYSIS

Suitability analysis for core habitat



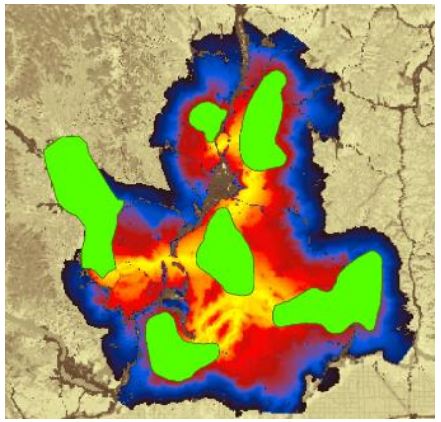




Opportunities + Constraints = Core Habitat

A. SPATIAL ANALYSIS

LinkageMapper Corridor Analysis



Build Network and Map Linkages

Linkage Mapper is a GIS tool designed to support regional wildlife habitat connectivity analyses. It consists of several Python scripts, packaged as an ArcGIS toolbox, that automate mapping of wildlife habitat corridors. The scripts were developed for the Washington Wildlife Habitat Connectivity Working Group's 2010 statewide connectivity analysis.

Climate Linkage Mapper

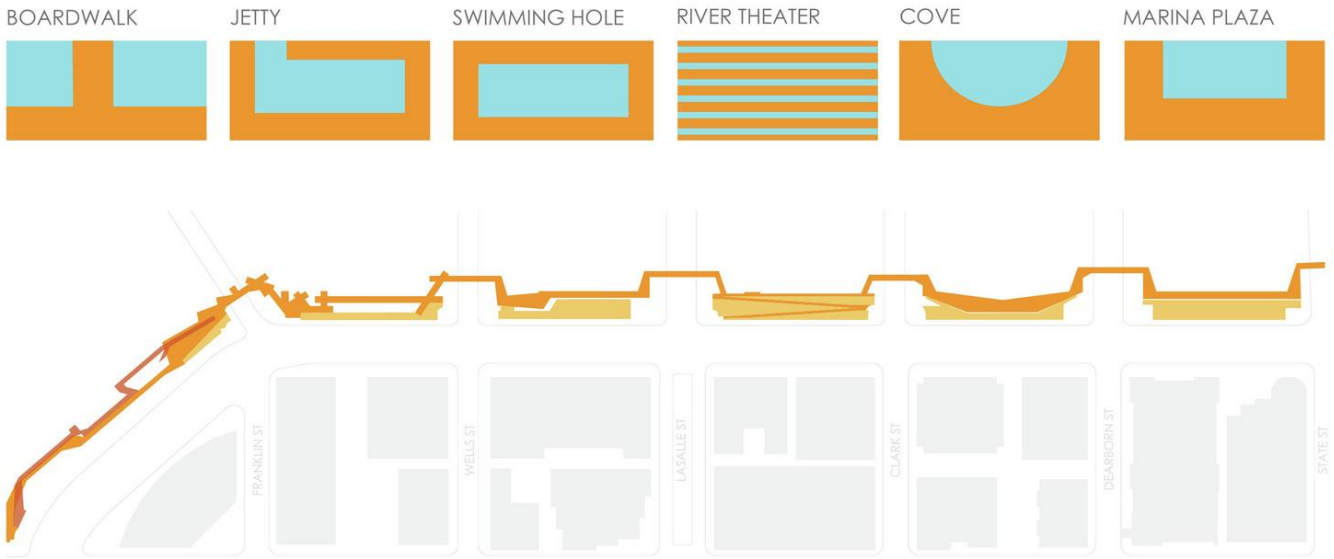
Climate Linkage Maper is part of the Linkage Mapper Toolkit, which includes Linkage Mapper (McRae and Kavanagh 2011) and other modules designed to support regional wildlife habitat connectivity analyses. The tool is designed to create linkages between designated core areas that fall along a climatic gradient (e.g. temperature). More details on climate corridor theory and approaches to modeling climate corridors can be found in Nuñez (2011), Washington Wildlife Habitat Connectivity Working Group (WHCWG) (2011) and WHCWG (2012).

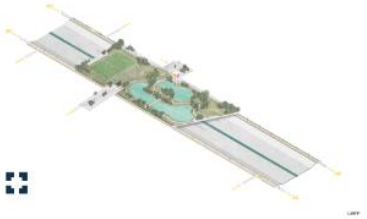
- Core Area – *Suitability of Core Habitat*
- Resistance Raster
- Climate Raster

Potential to use species distribution and climate projection data as "check point" (Point Blue and other resources)

B. PLANNING

Typologies of corridors and barriers: Case Studies

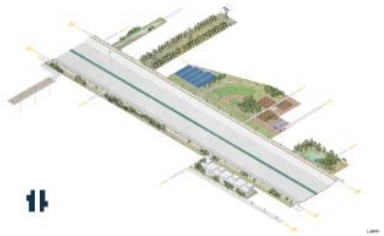




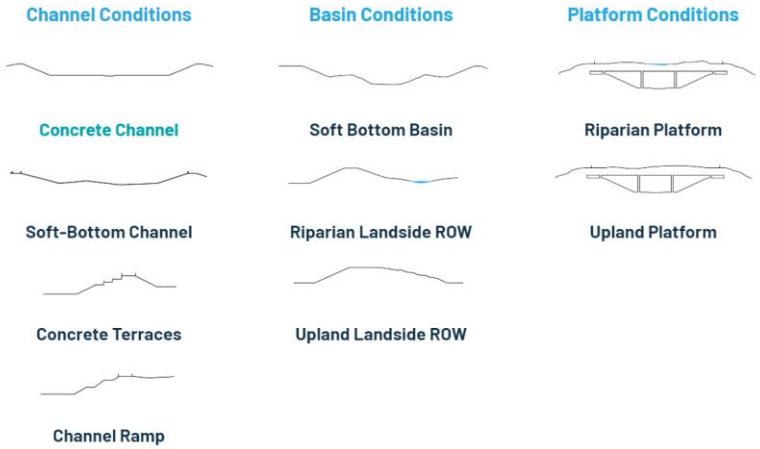
Crossings & Platforms

Floodplain Reclamation

Diversions



Off Channel Land Assets



KIT OF PARTS

The LA River Master Plan utilizes a kit of parts that includes possible design typologies for sites along the LA River. Each typology is associated with certain Master Plan goals. These parts may be combined in different ways and are intended to support biodiversity of species & habitats along the river.

C. DESIGN

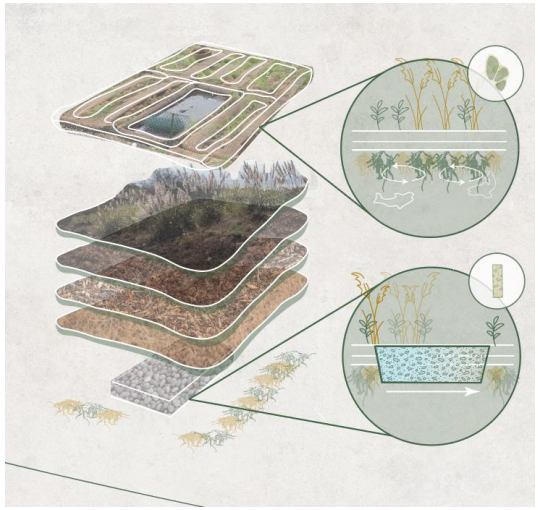
Potential Sample Design Project:

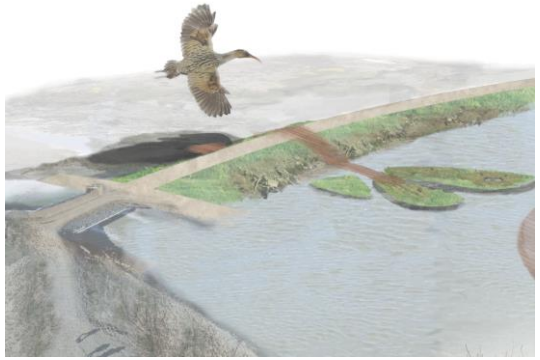
Point Reyes

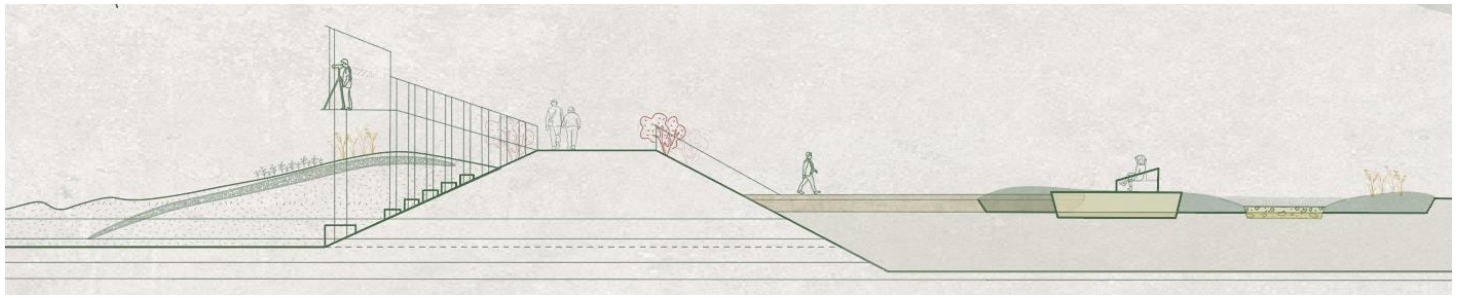





Site Visits & Photo-Journaling





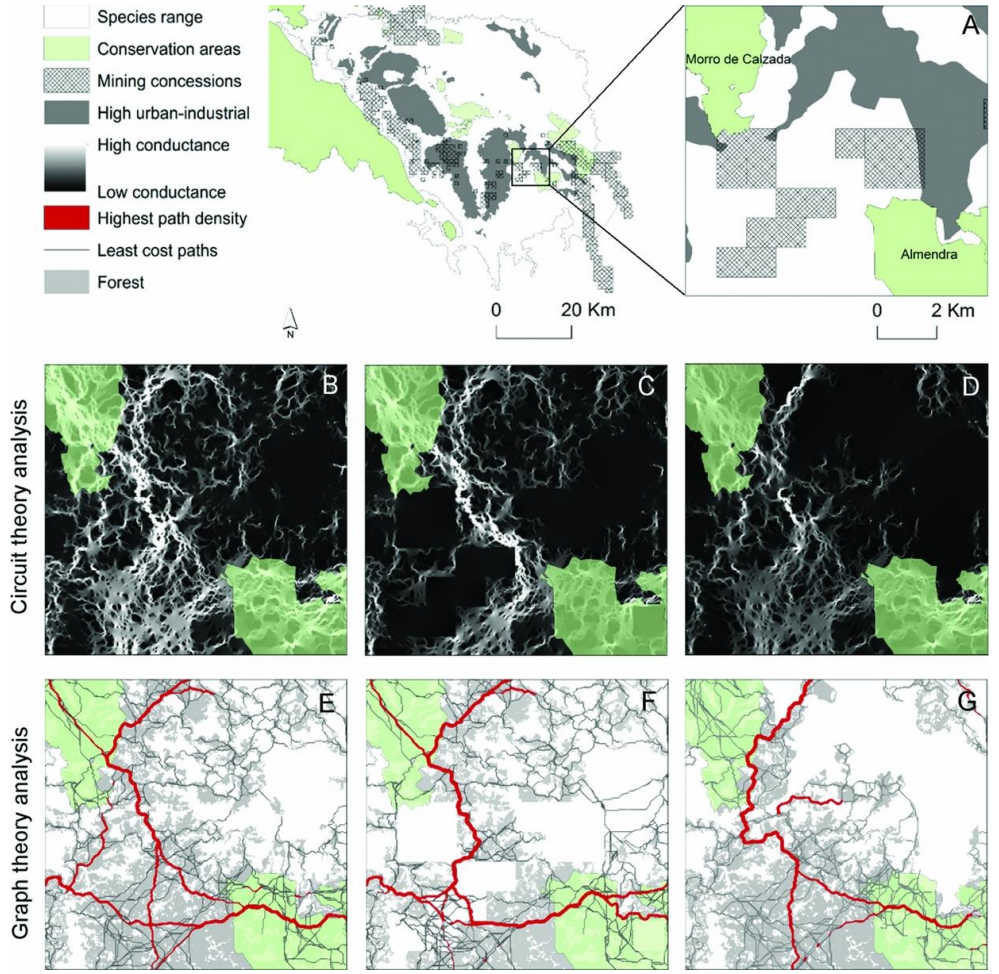


Plan, Section, Axon & Diagrams, Perspectives

IV. BIBLIOGRAPHY (Some Notable Resources)

Spatial Analysis & Planning

- Achieving climate connectivity in a fragmented landscape *By Jenny L. McGuire et. al.*
- Principles of Wildlife Corridor Design *By Monica Bond*
- Wildlife Connectivity: Fundamentals for conservation action *By The Center for Large Landscape Conservation*
- Rapid conservation assessment for endangered species using habitat connectivity models *By Danica Schaffer-Smith*



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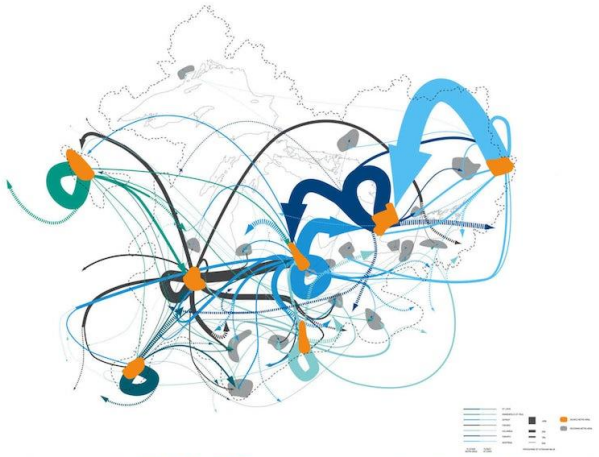
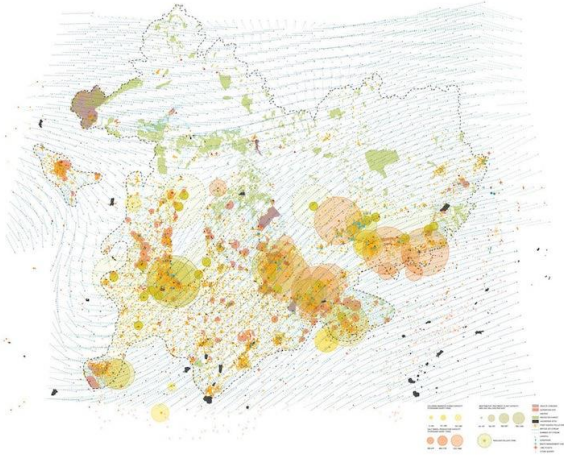
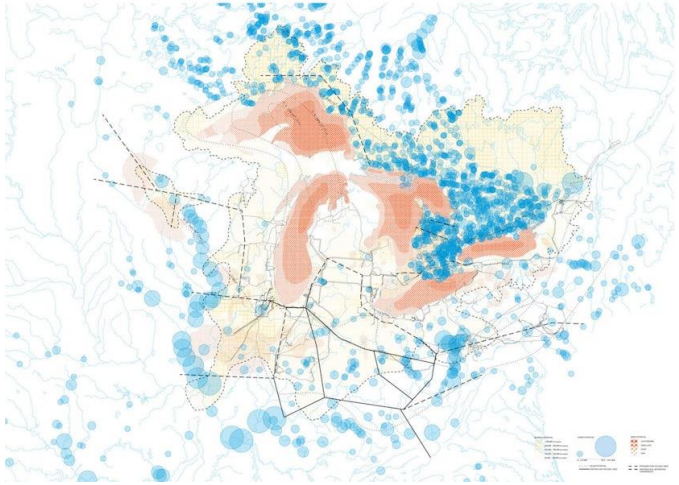
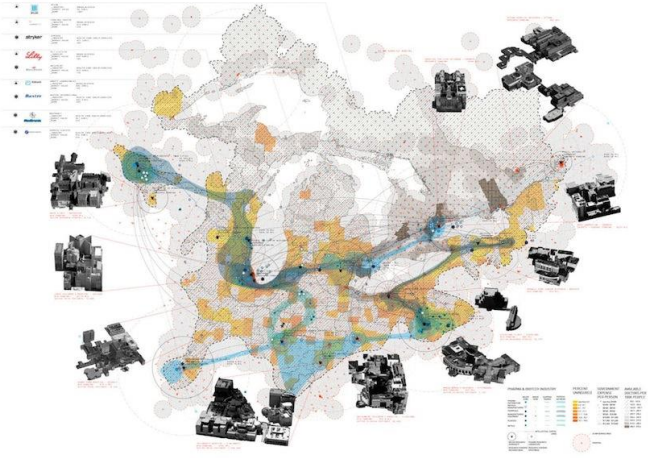
Landscape Architecture

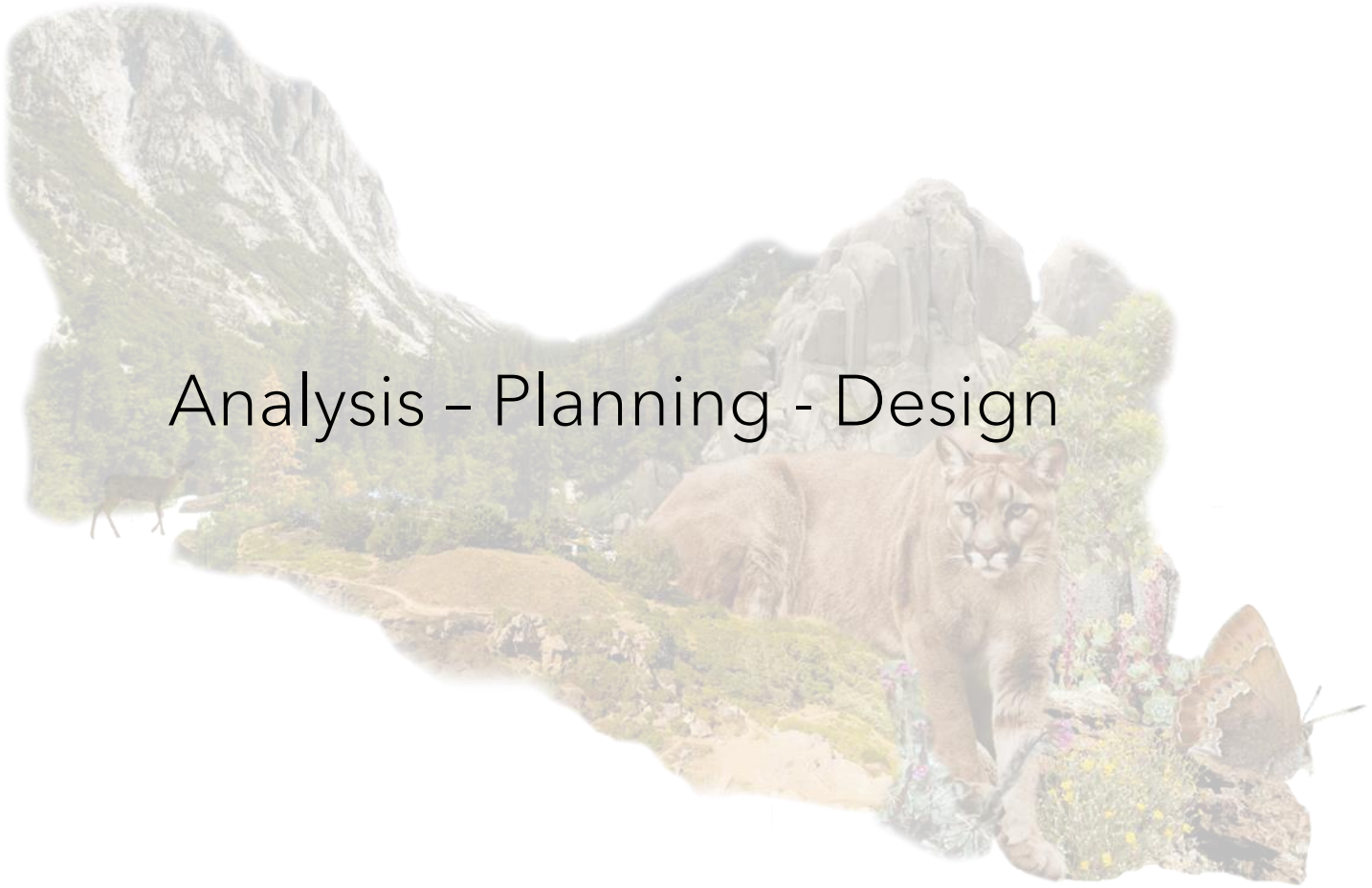
- Four Corridors: Design Initiative for RPA's Fourth Regional Plan *By Lewis Nordenson Seavitt*
- Patch Analysis *By Victoria J. Marshall et.al.*
- Infra Eco Logi Urbanism: A Project for the Great Lakes MegaRegion *By Geoffrey Thun et.al.*
- Resilient City: Landscape Architecture for Climate Change *By Elke Mertens*











Analysis – Planning - Design