Lower Columbia River Land Change

Jacob Hendrickson | Geo 580 Advanced GIS | Spring 2009

Objectives

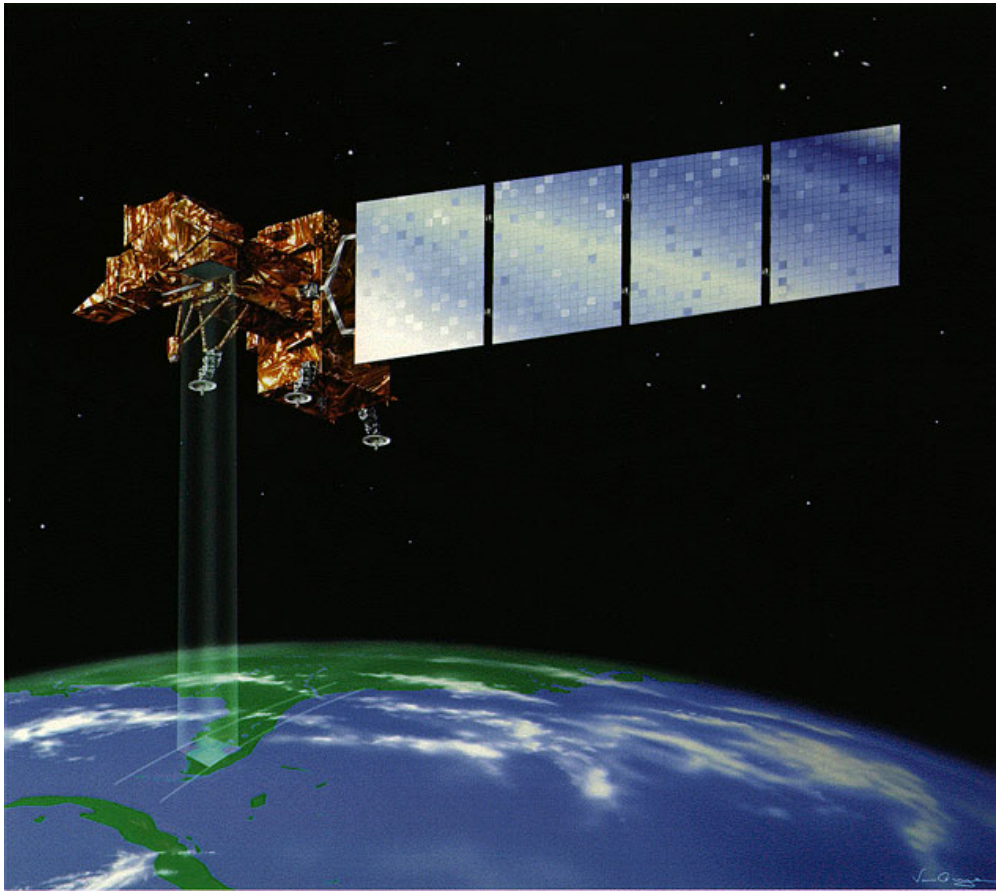
- Conduct land cover change analysis in the Lower Columbia River.
- Multi-Resolution Land Characteristics Consortium (MRLC).
- Learn to Use Land Change Molder Extension
- Explore alternative data structure and representation.
- Investigate Spatial Decision Support System (SDSS)

Multi-Resolution Land Characteristics Consortium (MRLC).

- Federal agency collaboration to provide digital land-cover data to the nation.
- USGS, EPA, NOAA, USFS, BLM, USFWS, NASA OSM, NRCS
- Began 1990s as a result of increasing cost of acquiring satellite imagery
- Based on Landsat series of sensors

Landsat imagery

- 1972 – present
- Continuous record of earths observations
- Many indices and classification techniques that have been tested, validated, and supported

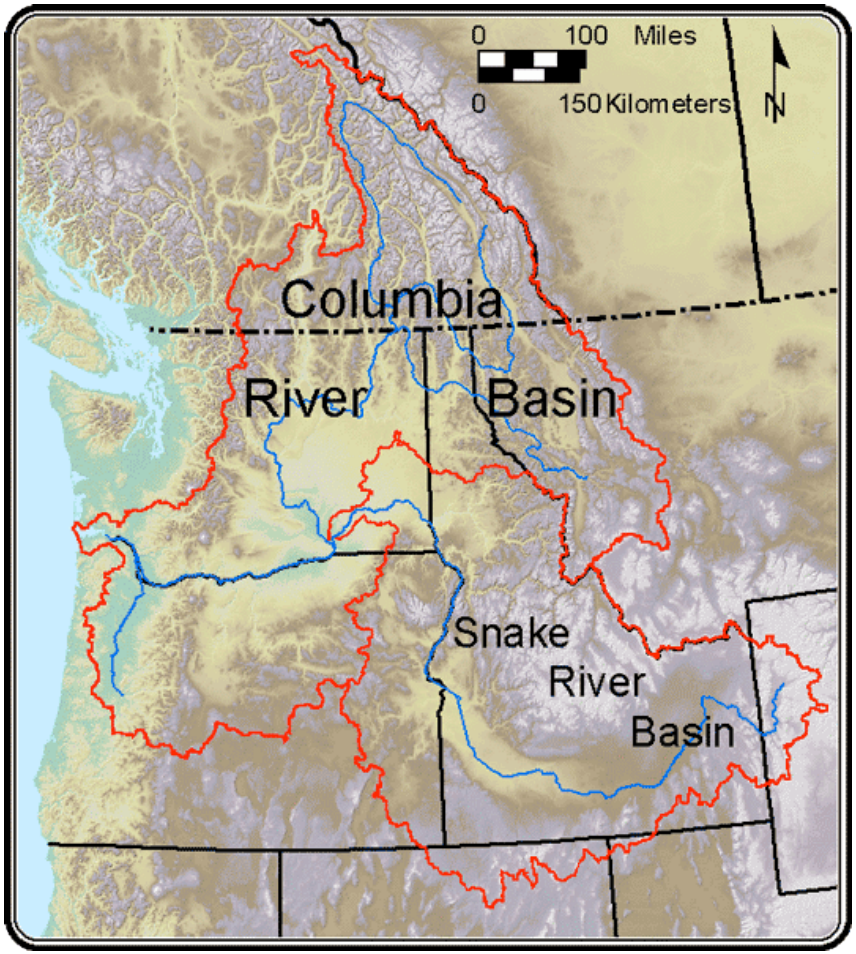


Land Cover Change

- Anthropogenic change/impact
  - Hydrologic alteration
  - Urban development and planning/Change in impervious surfaces
  - Introduction of invasive species
  - Changing management
- Natural Processes
  - Biochemistry
  - Erosion/Sedimentation
  - Vegetation succession
  - Tidal Fluctuation
  - Wildlife habitat

Columbia River Basin

- 2nd largest river, by annual discharge, in the United States
- Seasonal variations 2,000 m^3/s - 10,000m^3/s
- Basin area ~700,000 km^2



Lower Columbia River

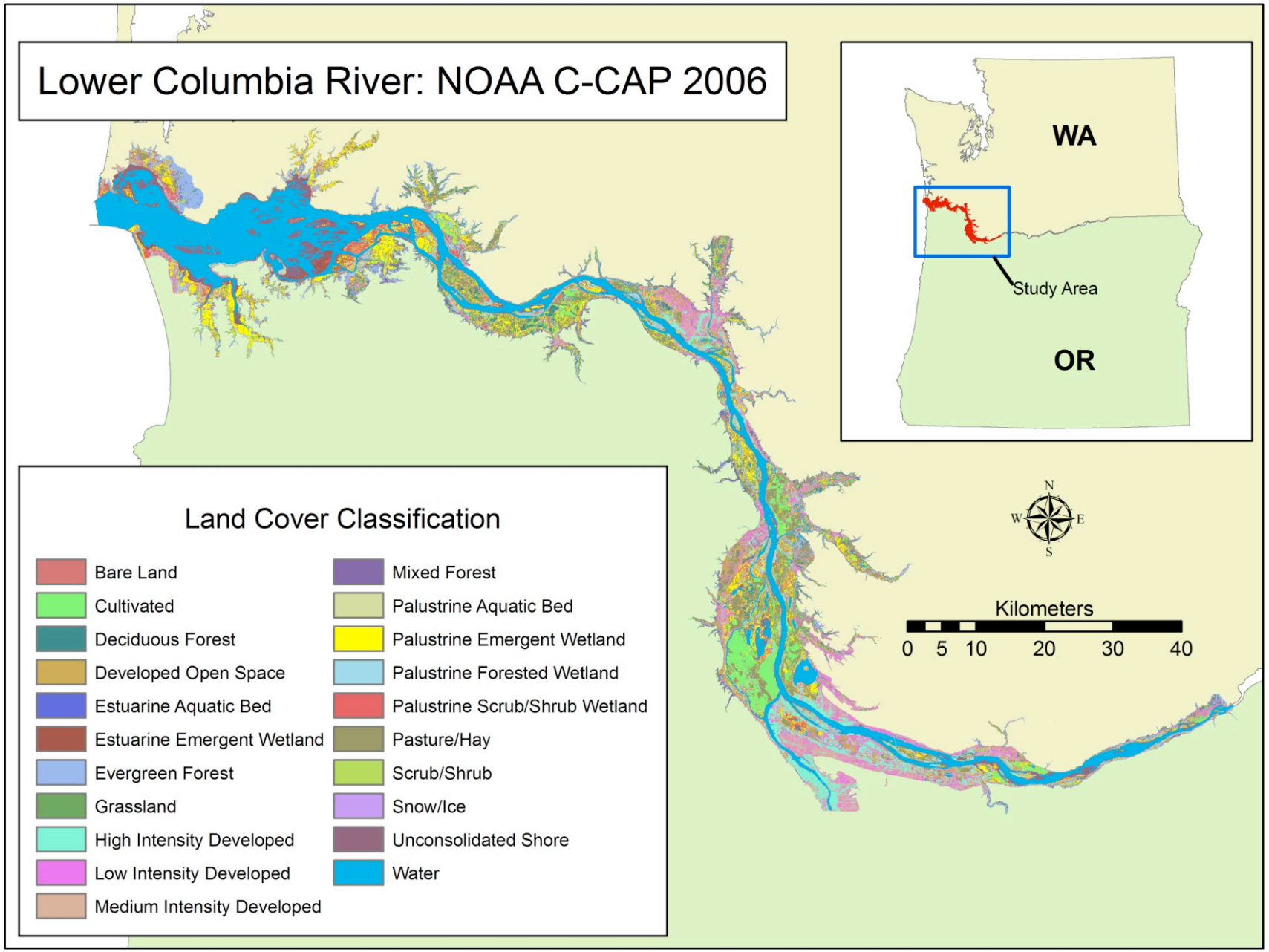
- River kilometer 234 downstream to the Pacific Ocean

Available Land Cover Data

- Costal Change Analysis Program (C-CAP)
- Gap Analysis Program (GAP)
- National Land Cover Dataset (NLDC)
  - Great variations in classification schemes
  - Classified Landsat Data 30m resolution

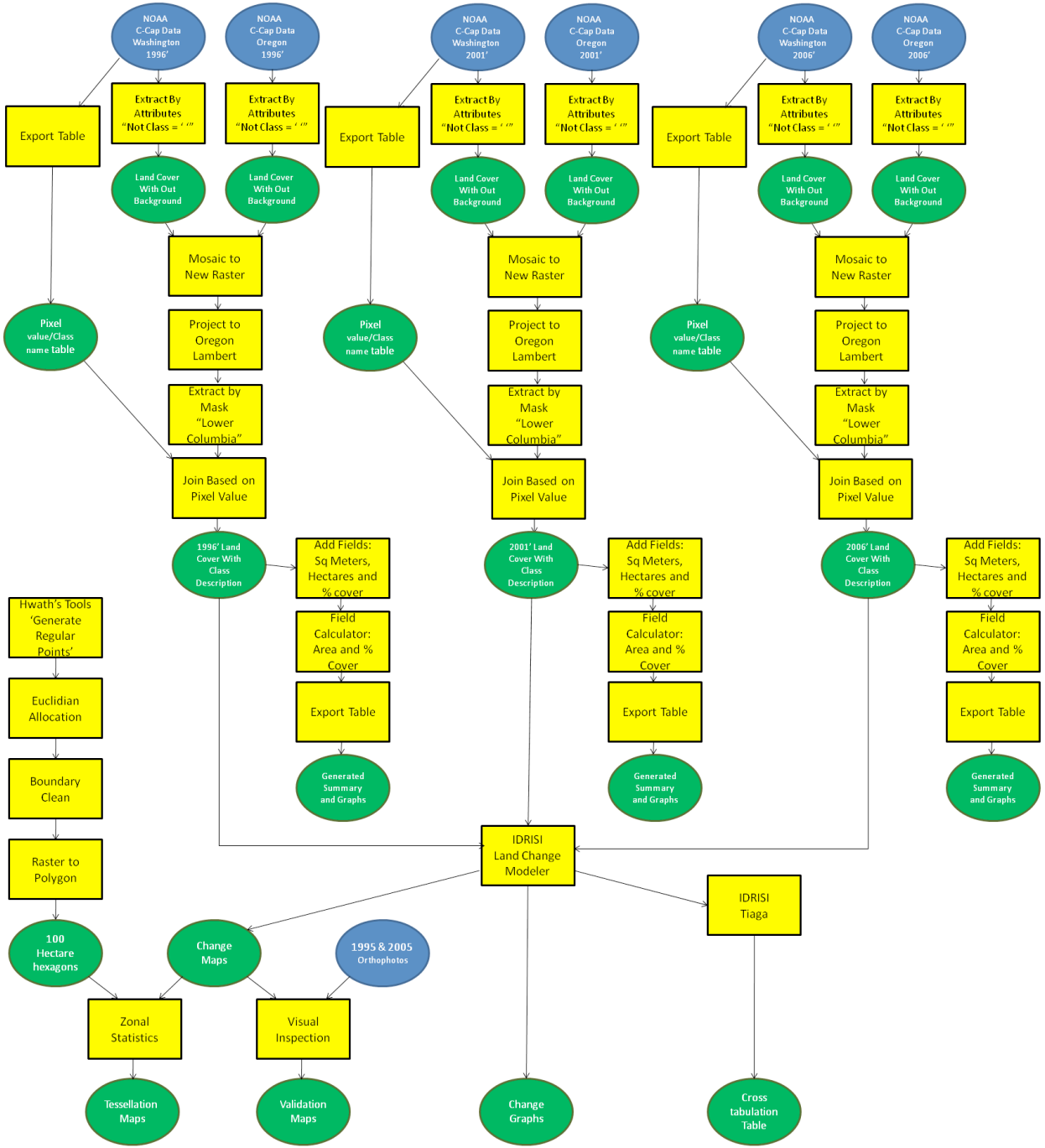
NOAA C-CAP Data

- “primary objective of the Coastal Change Analysis Program (C-CAP) is to improve scientific understanding of the linkages between coastal wetland habitats, adjacent uplands, and living marine resources” (http://www.csc.noaa.gov/crs/lca/history.html)
- 1996 & 2001 data available for download
- 2006 data received form NOAA
- 21 cover classes in study area

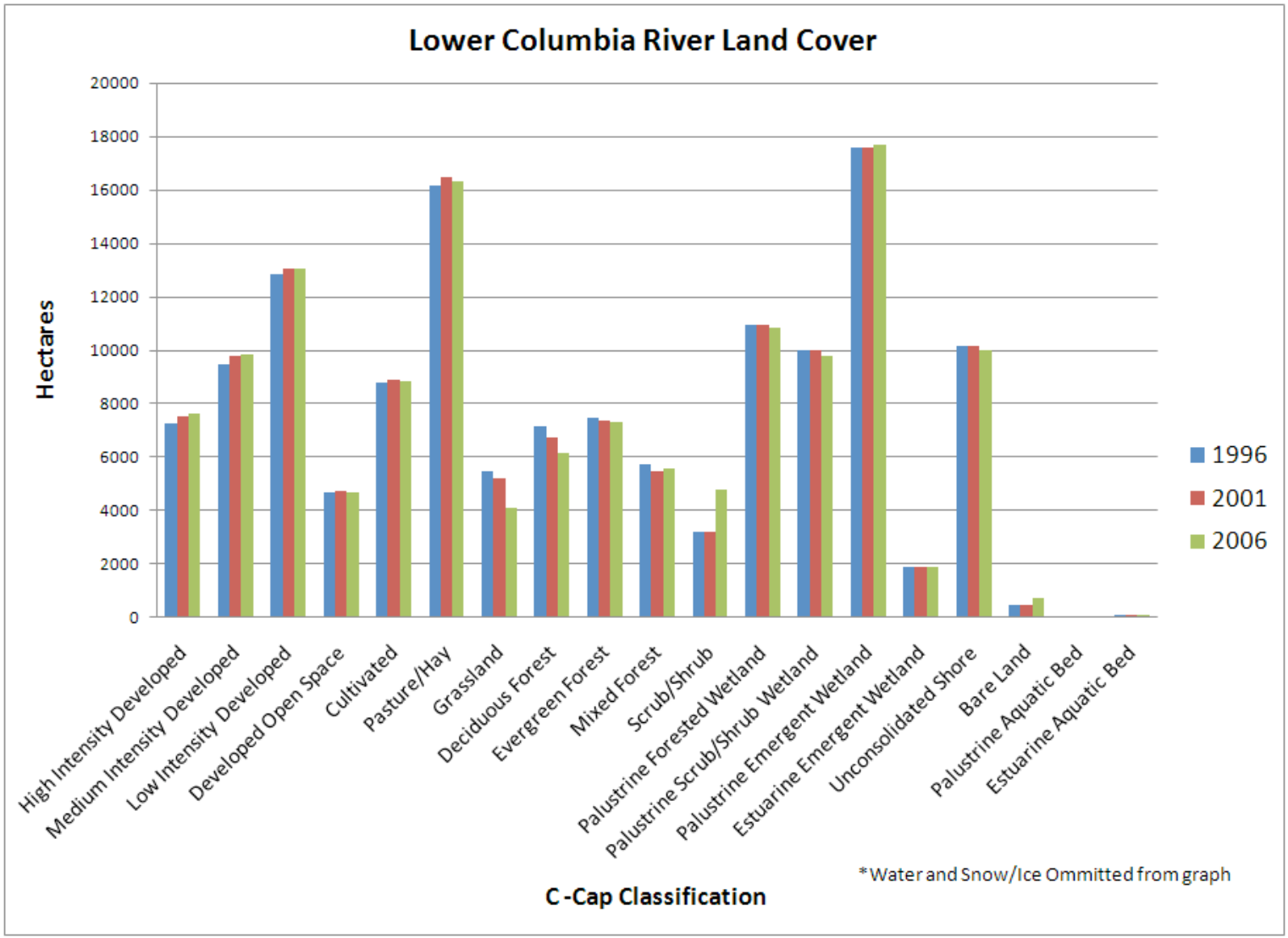

Lower Columbia River: NOAA C-CAP 2006
WA
OR
Study Area
Land Cover Classification
Bare Land
Cultivated
Deciduous Forest
Developed Open Space
Estuarine Aquatic Bed
Estuarine Emergent Wetland
Evergreen Forest
Grassland
High Intensity Developed
Low Intensity Developed
Medium Intensity Developed
Mixed Forest
Palustrine Aquatic Bed
Palustrine Emergent Wetland
Palustrine Forested Wetland
Palustrine Scrub/Shrub Wetland
Pasture/Hay
Scrub/Shrub
Snow/Ice
Unconsolidated Shore
Water
N
W
E
S
Kilometers
0 5 10 20 30 40

Data Processing

- Separate Oregon and Washington Datasets
- Each contained a portion but not the complete study area
- Arc GIS 9.3.1 used for all processing
- Export tables, Extract by attributes , mosaic to new raster, project, extract by mask, join table.

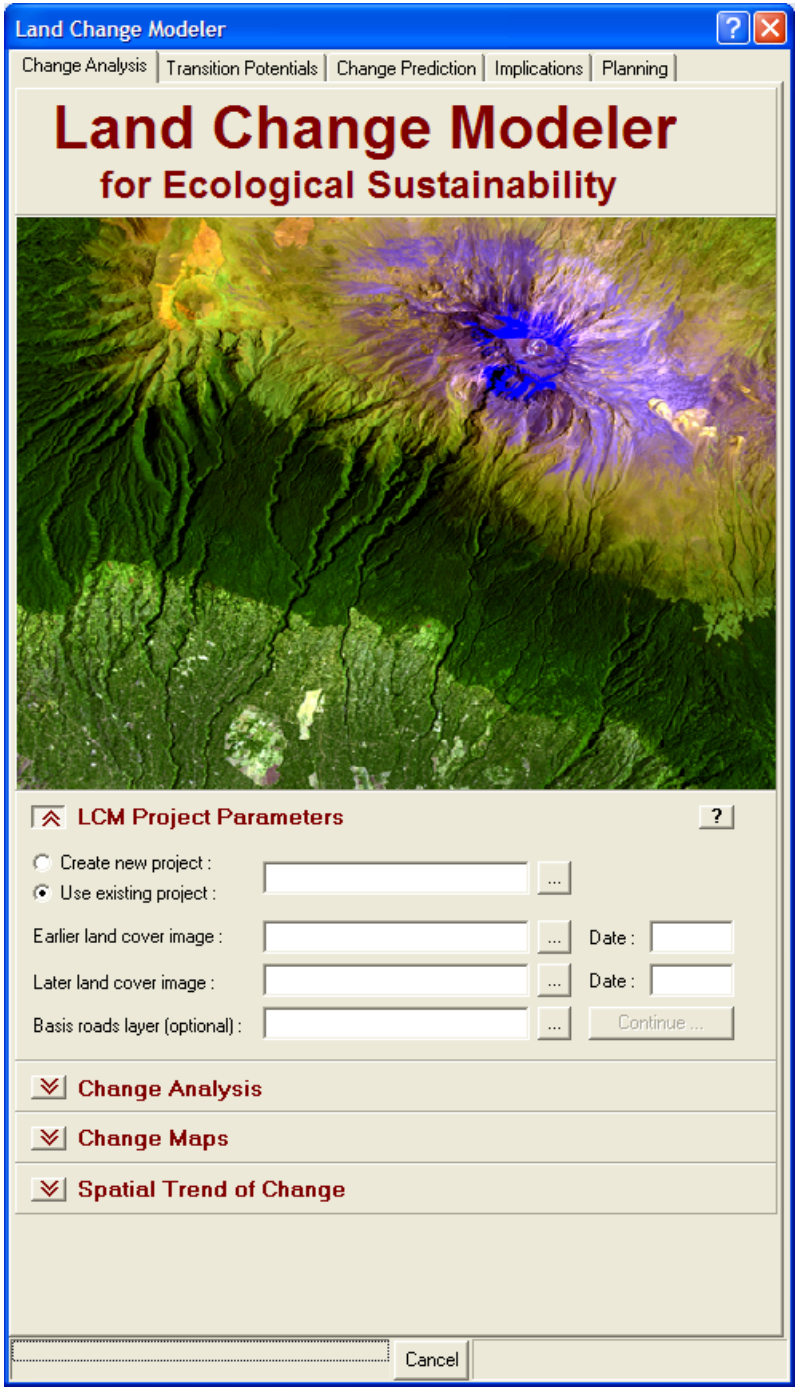

NOAA C-Cap Data Washington 1996'
NOAA C-Cap Data Oregon 1996'
NOAA C-Cap Data Washington 2001'
NOAA C-Cap Data Oregon 2001'
NOAA C-Cap Data Washington 2006'
NOAA C-Cap Data Oregon 2006'
Export Table
Extract By Attributes "Not Class = ' '"
Land Cover With Out Background
Mosaic to New Raster
Project to Oregon Lambert
Extract by Mask "Lower Columbia"
Pixel value/Class name table
Join Based on Pixel Value
1996' Land Cover With Class Description
2001' Land Cover With Class Description
2006' Land Cover With Class Description
Add Fields: Sq Meters, Hectares and % cover
Field Calculator: Area and % Cover
Export Table
Generated Summary and Graphs
Hwath's Tools 'Generate Regular Points'
Euclidian Allocation
Boundary Clean
Raster to Polygon
100 Hectare hexagons
IDRISI Land Change Modeler
IDRISI Tiaga
Change Maps
1995 & 2005 Orthophotos
Zonal Statistics
Visual Inspection
Tessellation Maps
Validation Maps
Change Graphs
Cross tabulation Table

C-Cap Land Cover in LCR



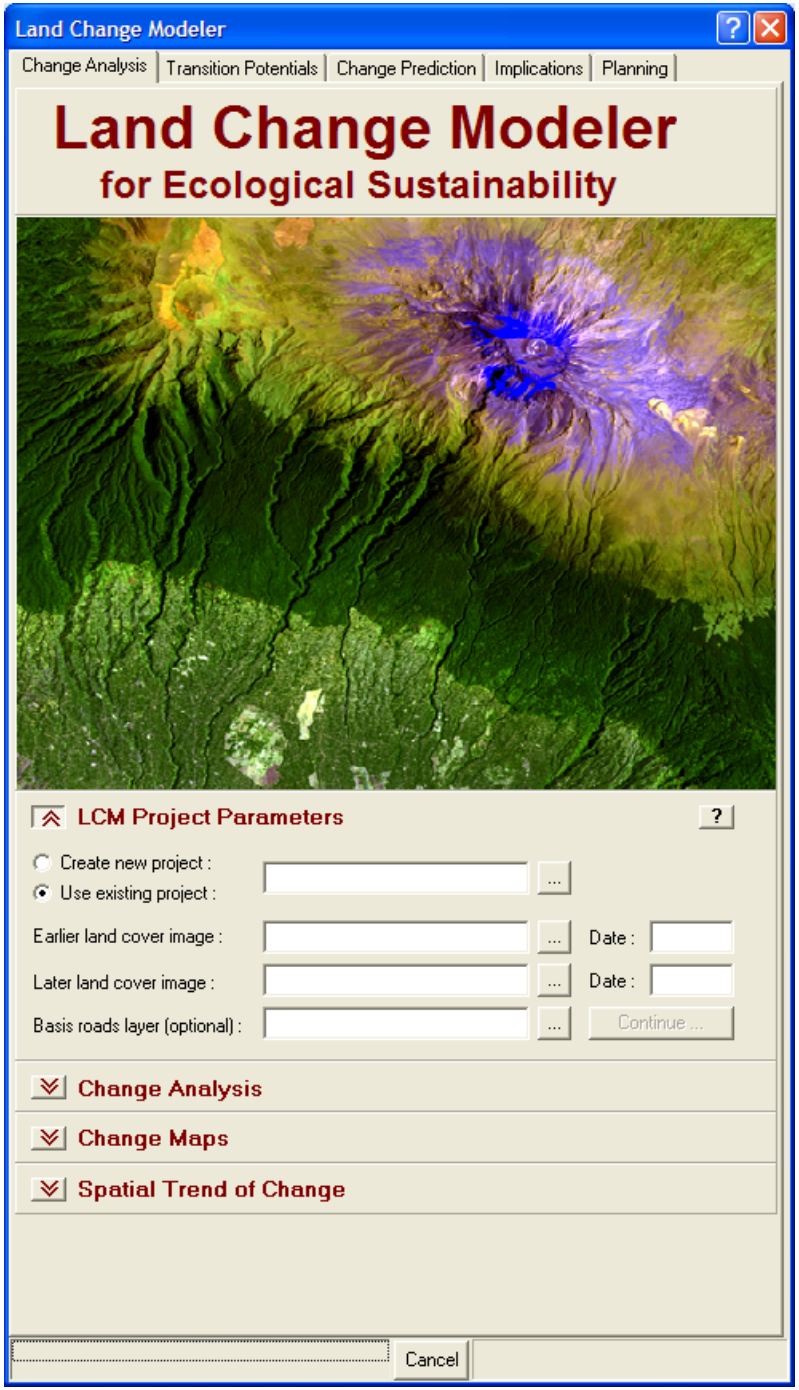
Land Change Modeler

- Clark Labs extension for ArcGIS
- From the producers of IDRISI GIS software
- Conducts change analysis
- Virtually no review Software
- 15 Day Trial
- Not Compatible with Geodatabase

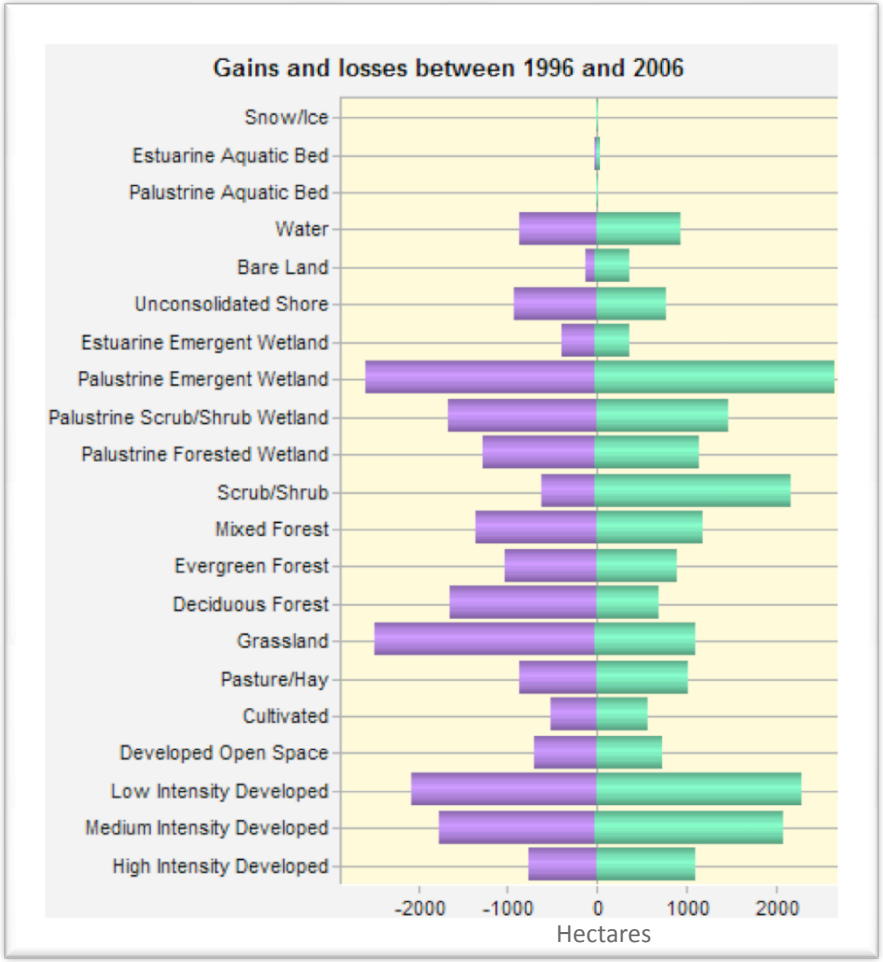


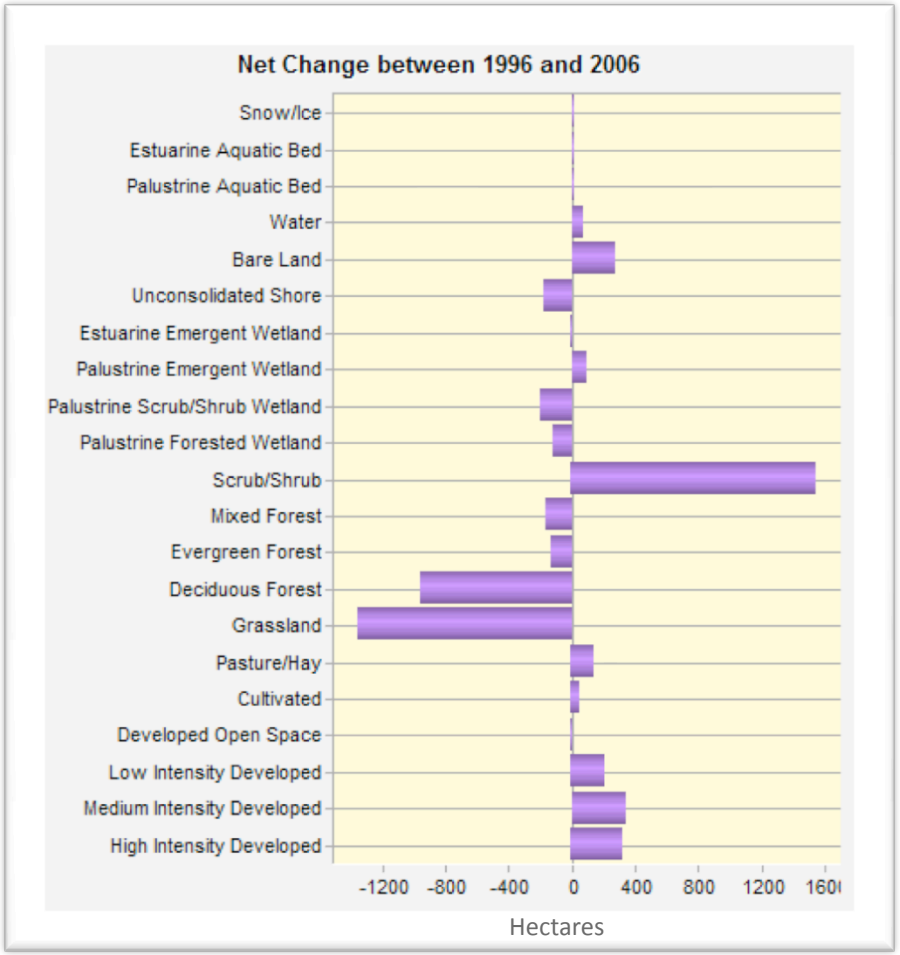
Land Change Modeler

- Change analysis
  - Cell by Cell analysis
  - To and from Classification
- Change prediction
  - Weighted Analysis
- Habitat Modeling
  - Primary/Secondary Habitat/Corridor

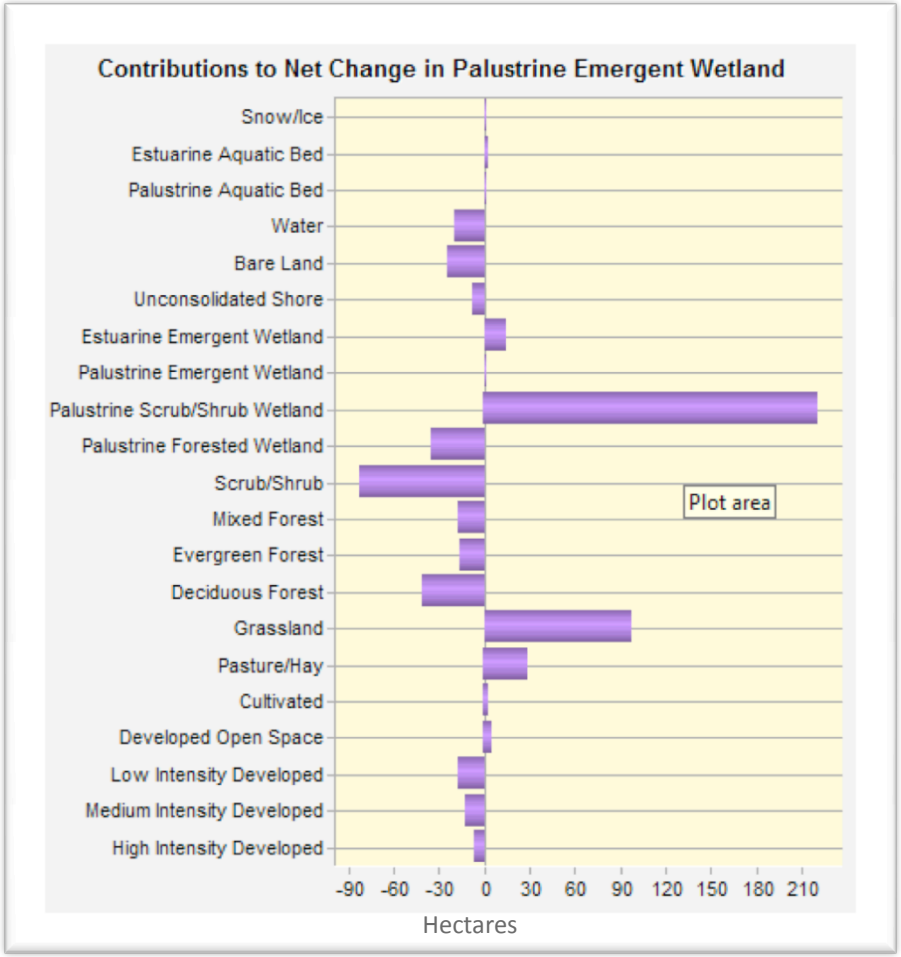


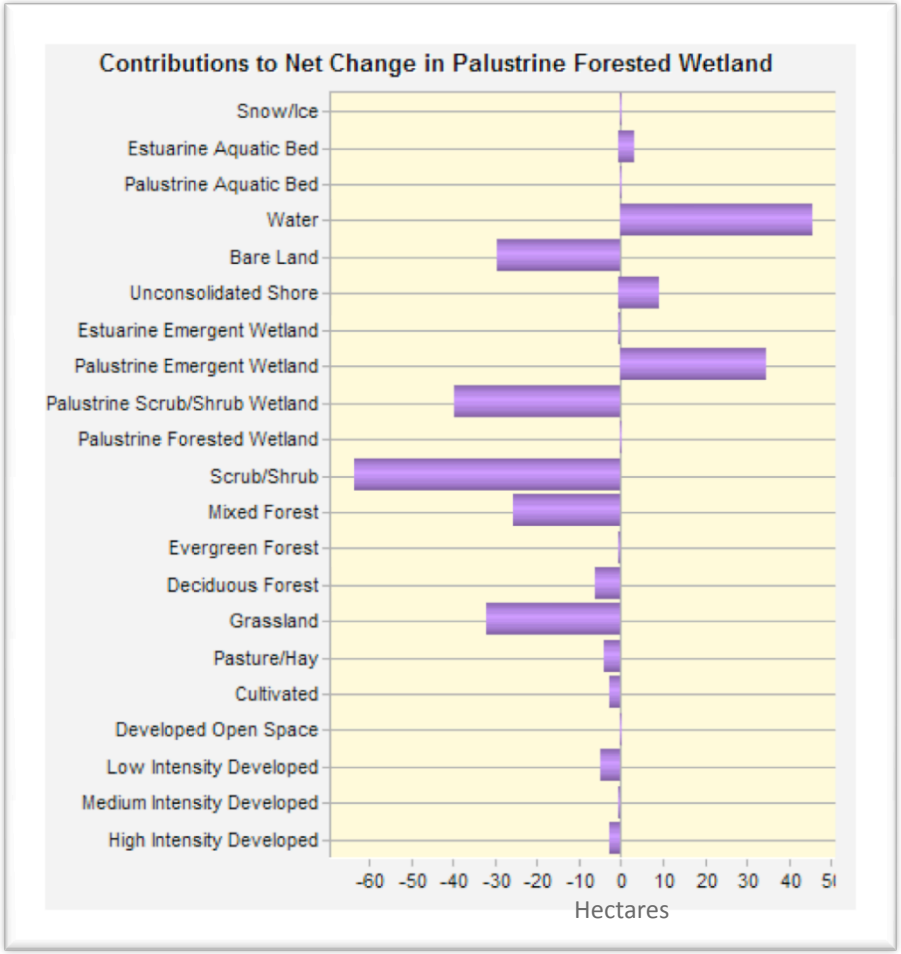
Land Change Graphs

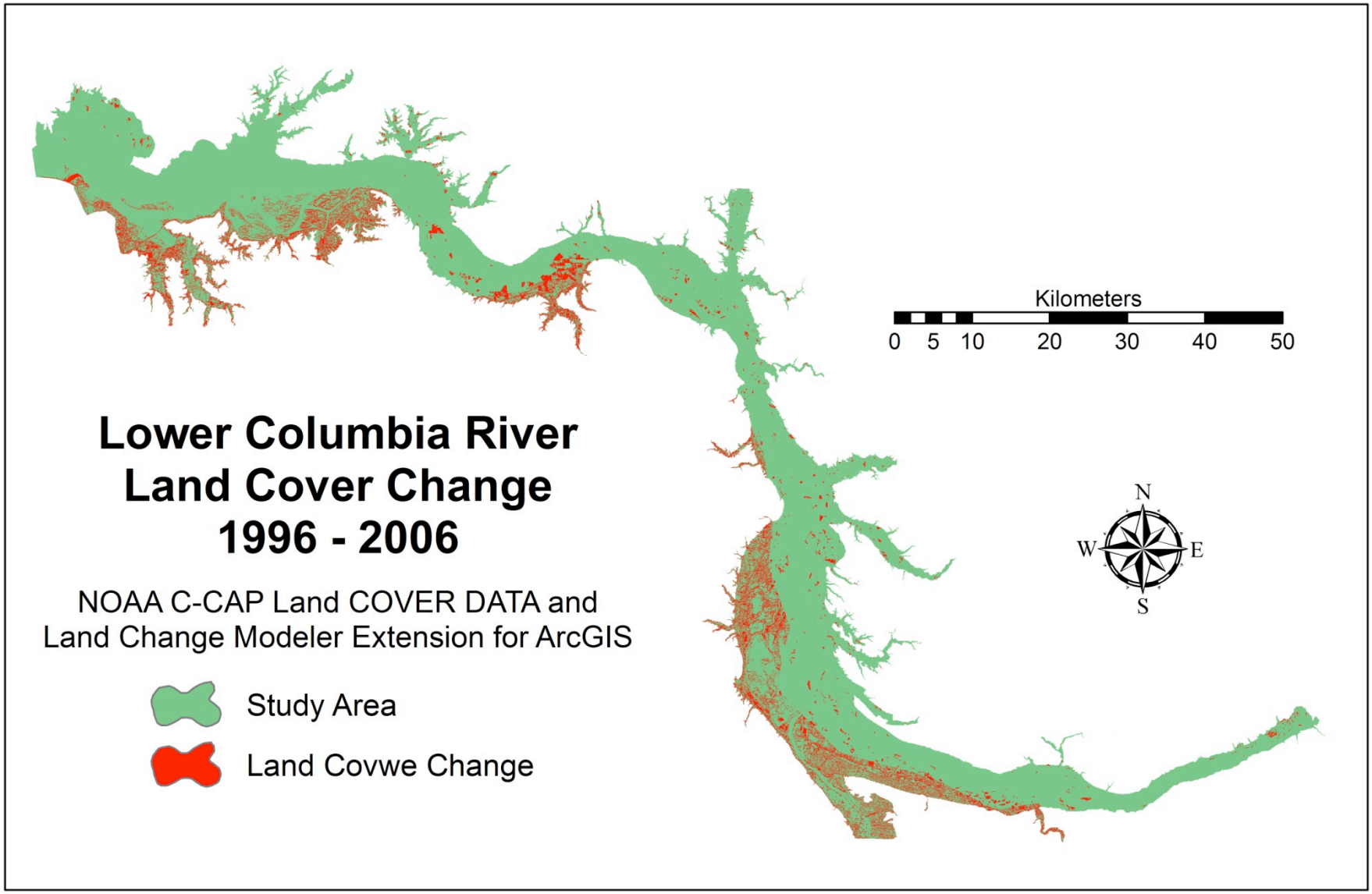




Change in Individual Class



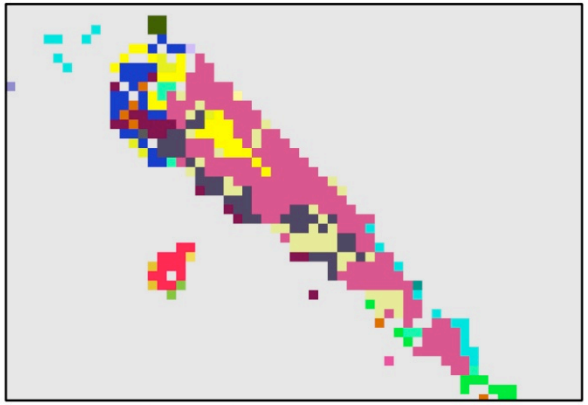



Kilometers
0 5 10 20 30 40 50
N
W
E
S
Lower Columbia River
Land Cover Change
1996 - 2006
NOAA C-CAP Land COVER DATA and
Land Change Modeler Extension for ArcGIS
Study Area
Land Covwe Change

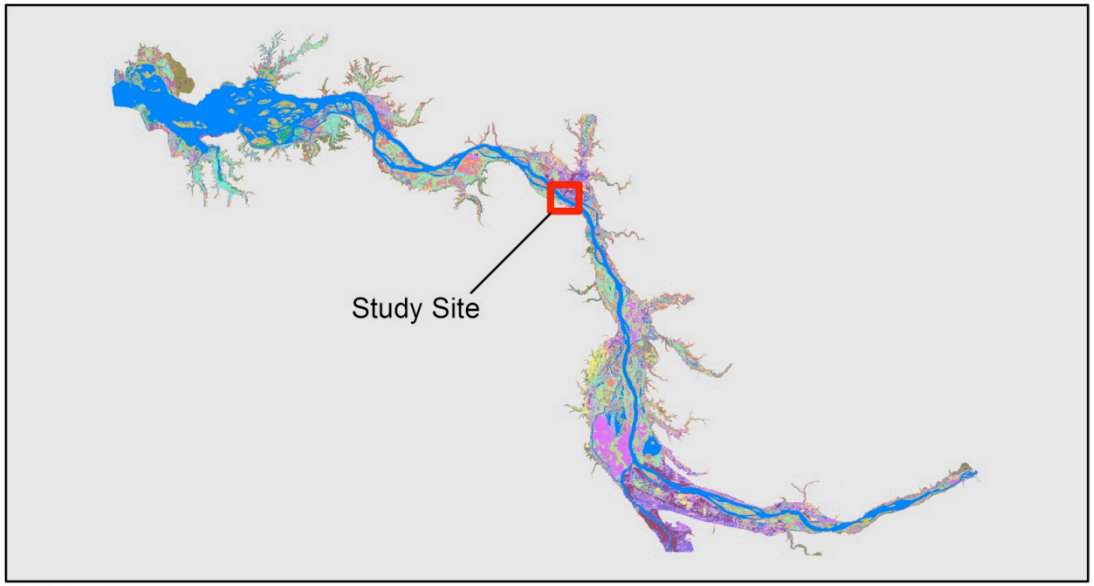
Verification

- Comparison of Orthophotos (1995 & 2005)
- Change to “Developed” easily recognized
- Vegetation classifications were not as clear
- Vegetation classification change followed property/parcel boundaries

Columbia River
Land Change Analysis
1996 - 2006
NOAA C-CAP Data



Change Detection

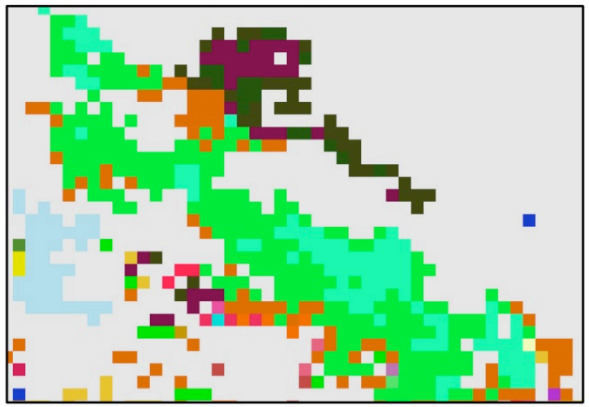


Study Area

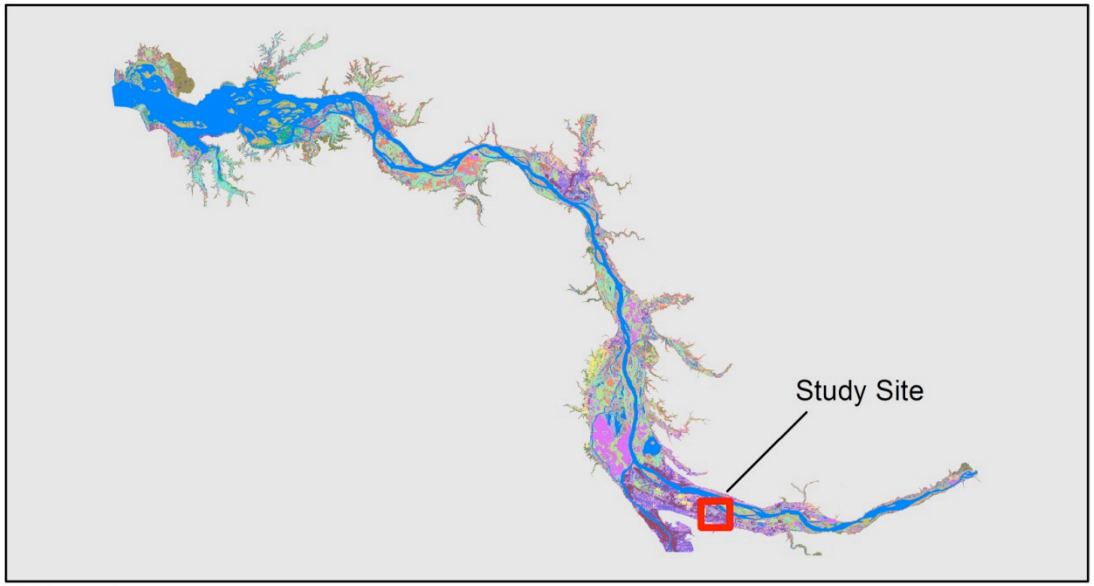
1995 Orthophoto

2005 Orthophoto

Columbia River
Land Change Analysis
1996 - 2006
NOAA C-CAP Data



Change Detection



Study Area

1995 Orthophoto

2005 Orthophoto

Hexagonal Tessellation

- 100 hectares Hexagons
- Nearest Neighbor
- Perimeter vs. Area
- Distance from center
- Hexagonal grids have been used in ecological sampling, experiment design, surveying and modeling.

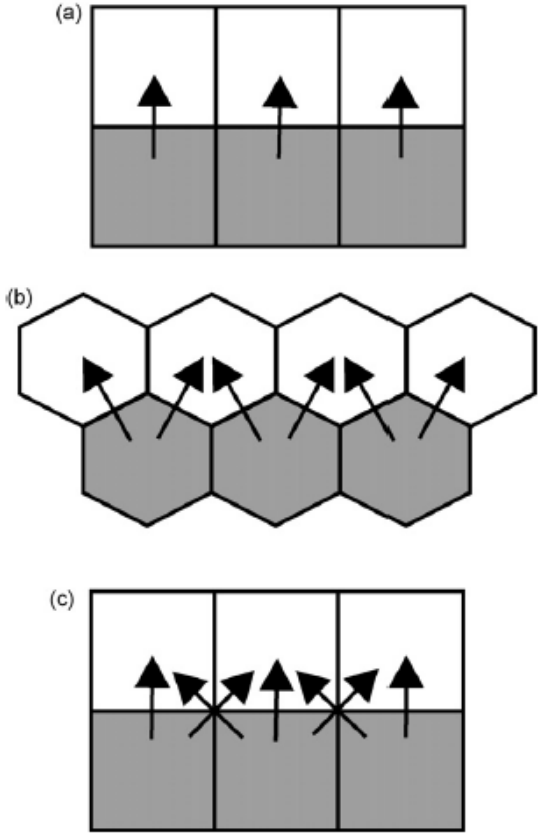
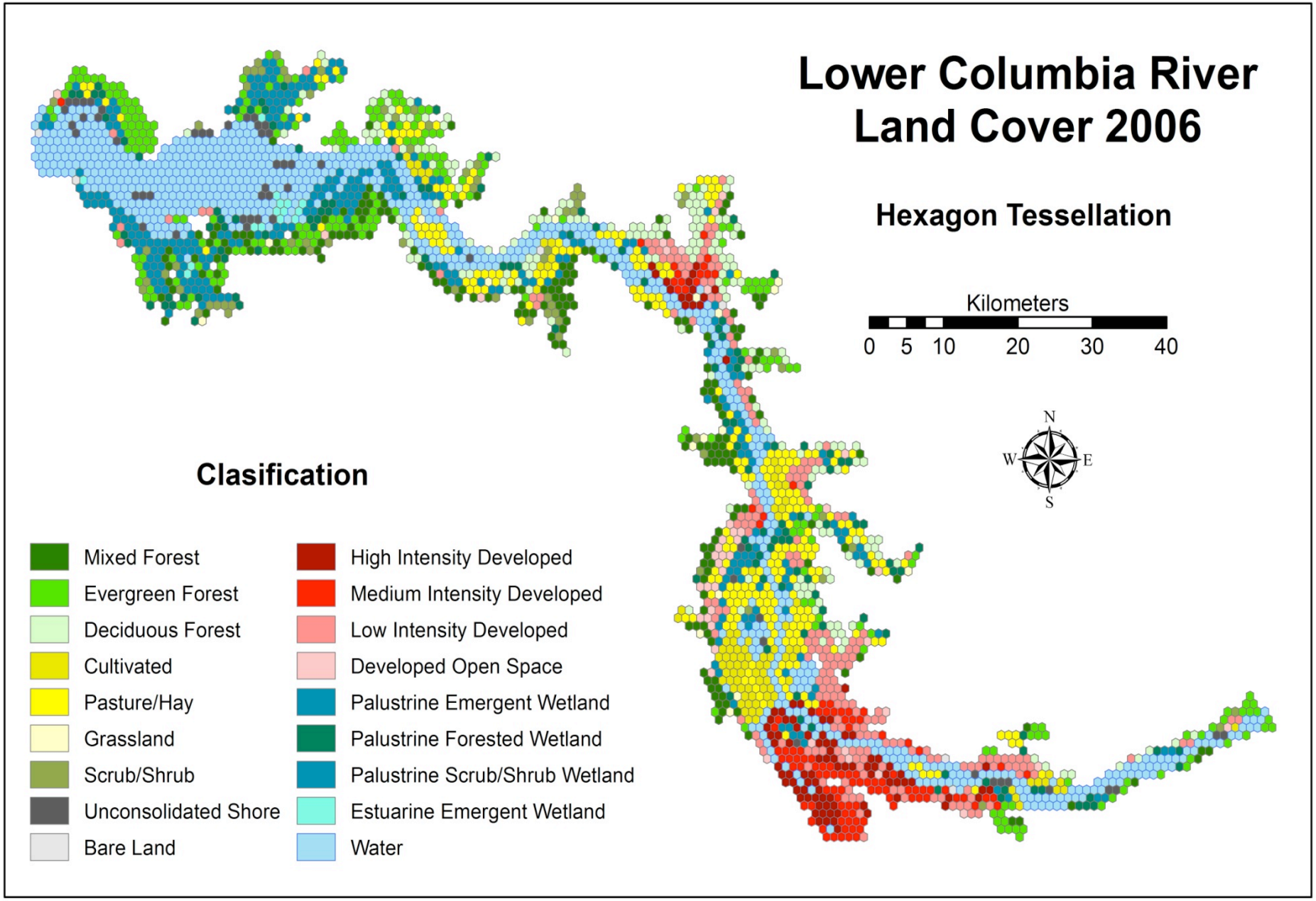


Fig. 3 – Potential nearest neighbour interactions at a boundary in a grid-based simulation. (a) With a four cell neighbourhood including only orthogonal neighbours, interactions are limited to pairs of cells. (b) In a hexagonal grid interactions are affected by neighbours. (c) With a eight cell neighbourhood including diagonal and orthogonal neighbours, interactions are affected by neighbours on both sides.


Lower Columbia River
Land Cover 2006
Hexagon Tessellation
Kilometers
0 5 10 20 30 40
N
W
E
S
Clasification
Mixed Forest
Evergreen Forest
Deciduous Forest
Cultivated
Pasture/Hay
Grassland
Scrub/Shrub
Unconsolidated Shore
Bare Land
High Intensity Developed
Medium Intensity Developed
Low Intensity Developed
Developed Open Space
Palustrine Emergent Wetland
Palustrine Forested Wetland
Palustrine Scrub/Shrub Wetland
Estuarine Emergent Wetland
Water

Spatial Decision Support System

- The hexagons are the final step in this analysis that lead to a Spatial Decision Support System.
- The hexagons used to visualize where change is occurring within equal area shapes over the study area.
- The hexagons are used to summarize net change, the areas experiencing the greatest loss can act as an area to focus mitigation, conservation or restoration efforts.

Results

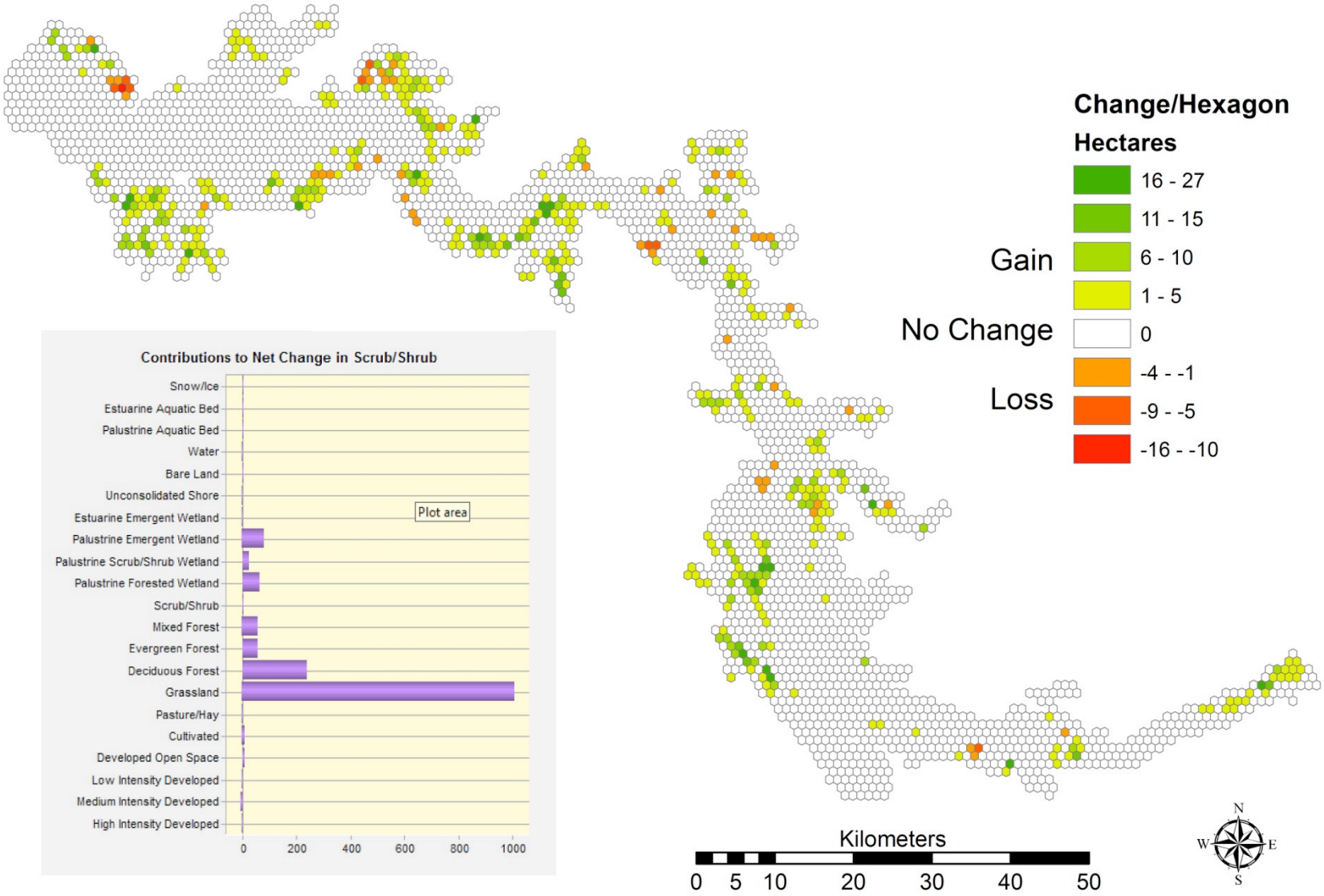
- 21445 Ha has experienced change in land cover
- 205 to and from cover classes
- 5 greatest change classes

Change 'form' & 'to'	Ha
Grassland to Scrub/Shrub	1080.2
Medium Intensity Developed to Low Intensity Developed	987.5
Low Intensity Developed to Medium Intensity Developed	986.9
Palustrine Scrub/Shrub Wetland to Palustrine Emergent Wetland	864.1
Medium Intensity Developed to High Intensity Developed	664.5

Results

- The single class with greatest net change was ‘Scrub/Shrub’
- Gained 2183 Ha
- Lost 629 Ha
- Net gain of 1554 Ha.

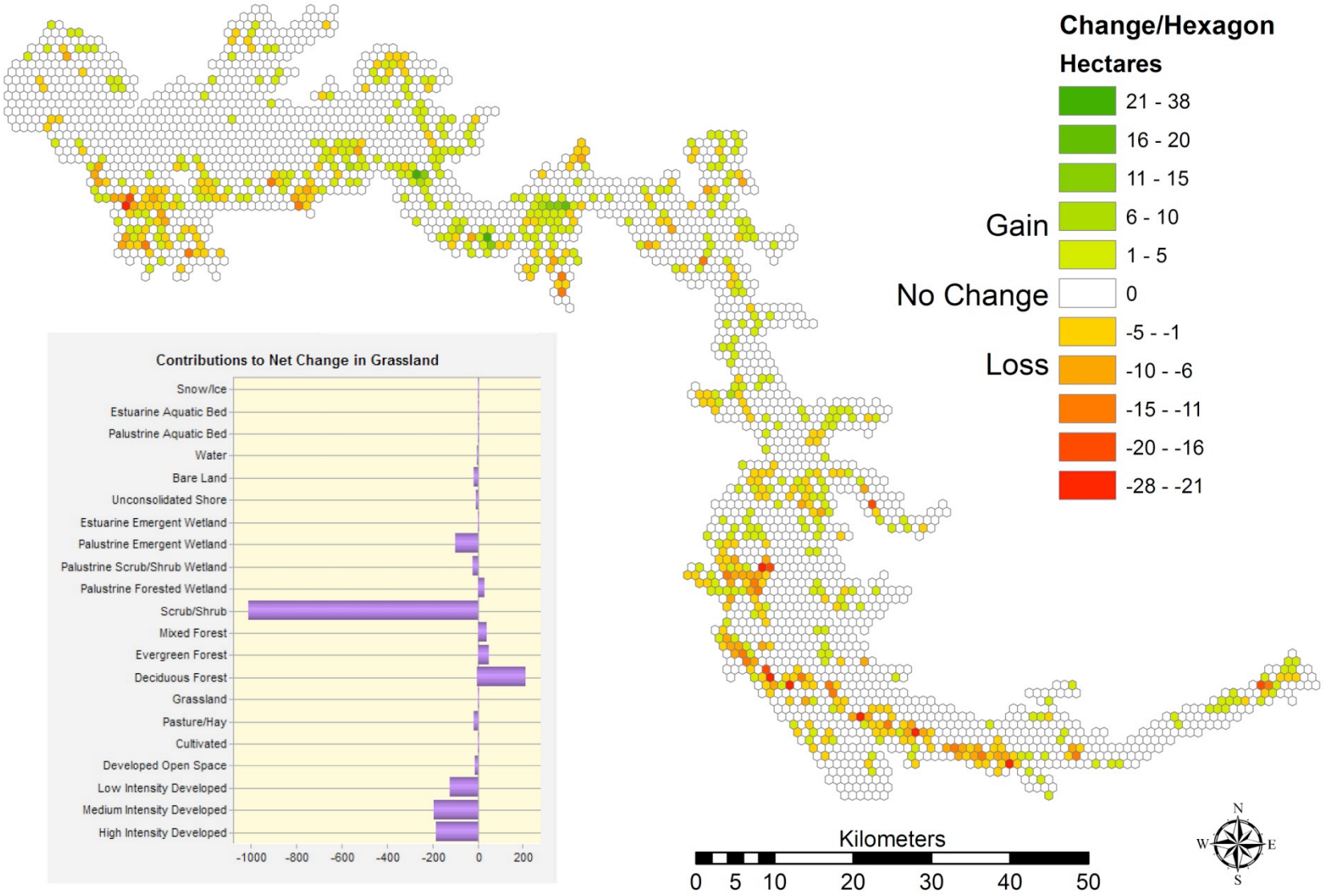
Net Change in Scrub/Shrub 1996 -2006



Results

- The class with the greatest loss was ‘Grassland’
- Lost 2496 Ha
- Gained 1133 Ha
- Net loss of 1363 Ha.

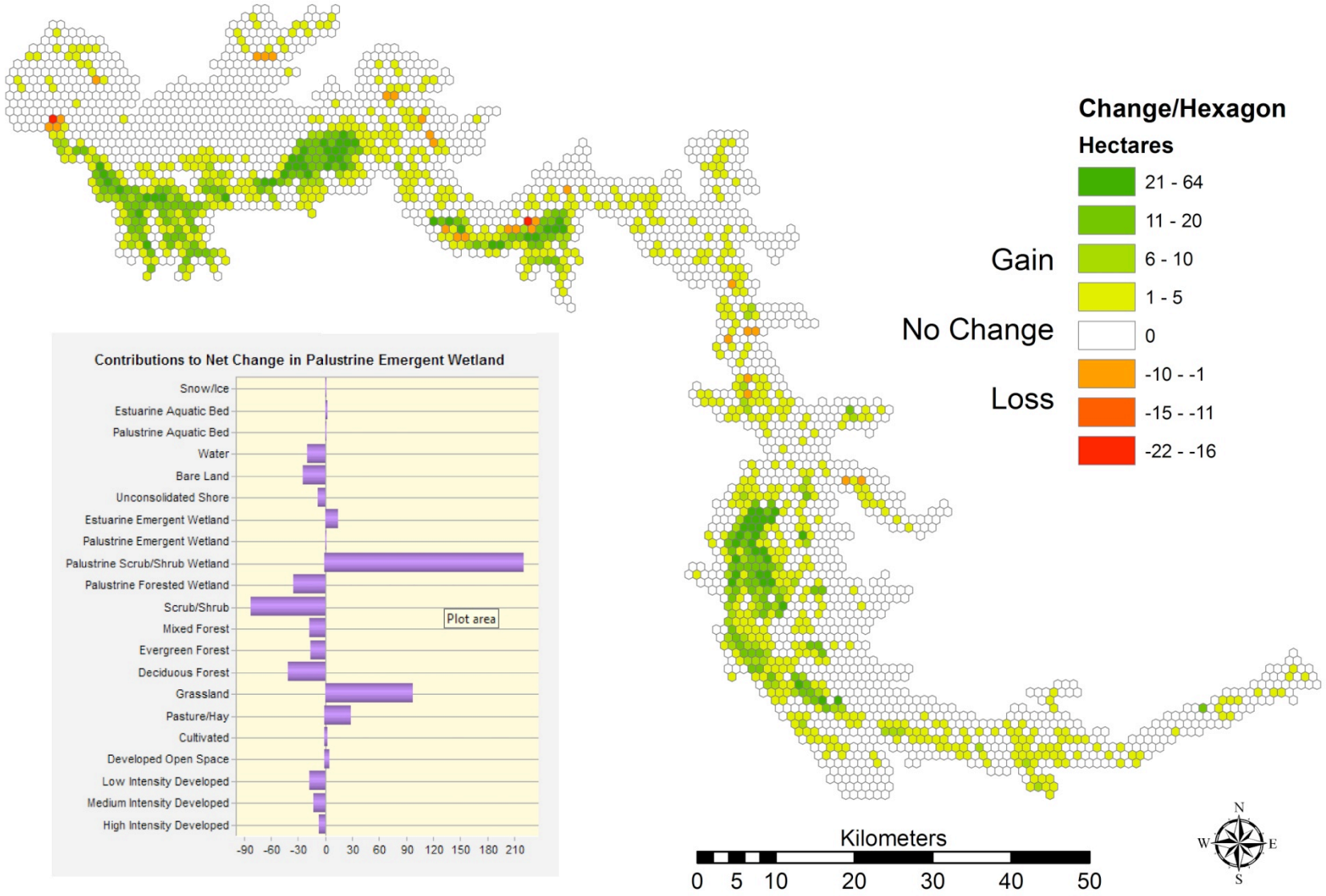
Net Change in Grassland 1996 -2006



Results

- Excluding ‘Water’ the cover class ‘Palustrine Emergent Wetland’ (PEW) is the dominant land cover in the LCR.
- PEW has experienced the greatest extent of gains and losses.
- The largest contributor to PEW was ‘Palustrine Scrub/Shrub Wetland’.

Net Change in Palustrine Emergent Wetland 1996 -2006



Discussion

- Understanding the anthropogenic and natural processes responsible for changes in land cover and ecosystem function over time is essential for interpreting and implementing SDSS analysis (Yang 2005).
- A SDSS is important for “the identification of habitats, trends in habitat change, and delineation of habitat for preservation, restoration or enhancement” (Garono et al, 2003).

Future analysis

- Fragstats
- IDRISI Taiga
- Change Detection using classified CASI (airborne hyper-spectral) data for mapping the change in the invasive plant purple loostrife and biocontrol in LCR

Questions/Discussion