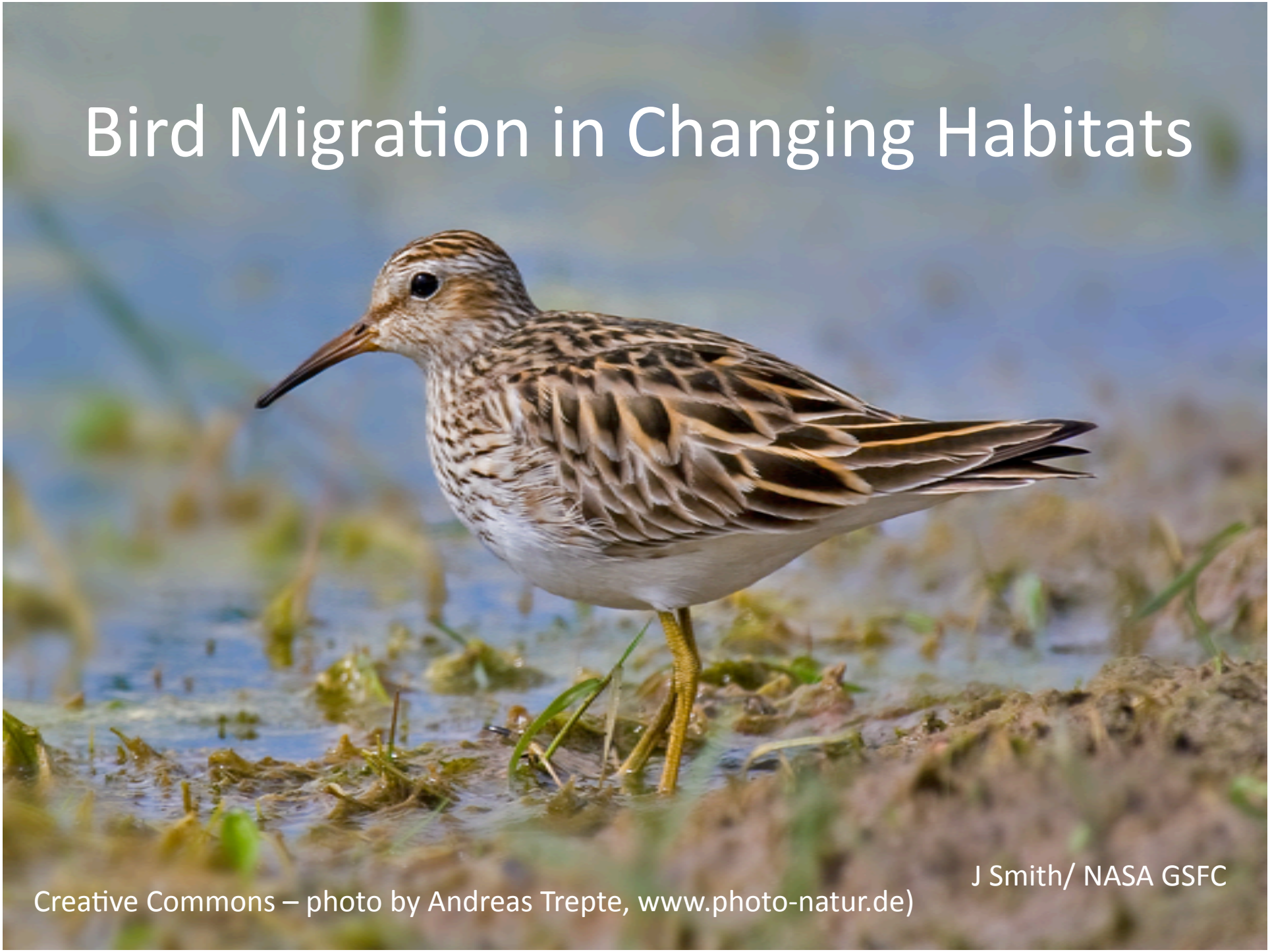
Bird Migration in Changing Habitats

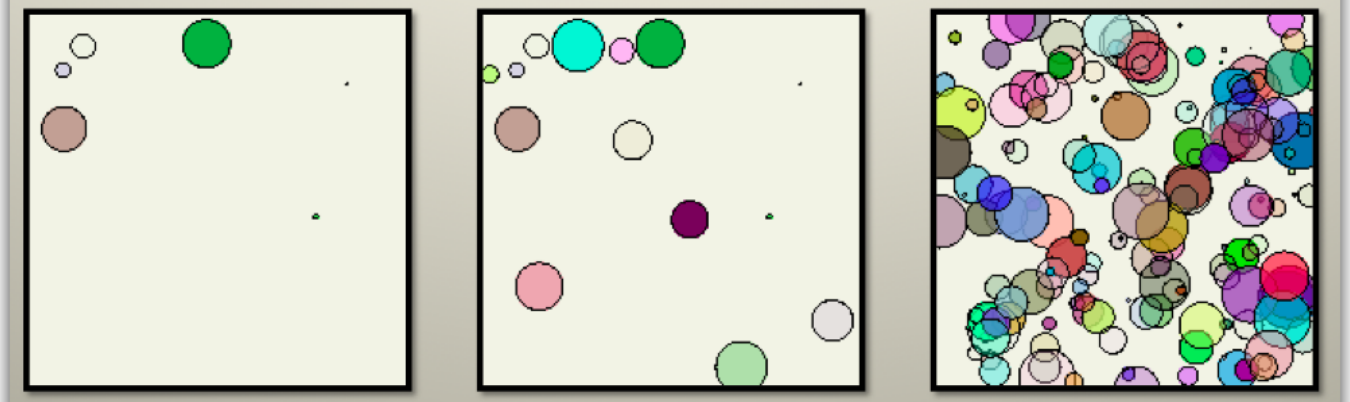


J Smith/ NASA GSFC

Creative Commons – photo by Andreas Trepte, www.photo-natur.de)

Last Time

Software Entropy Catastrophe



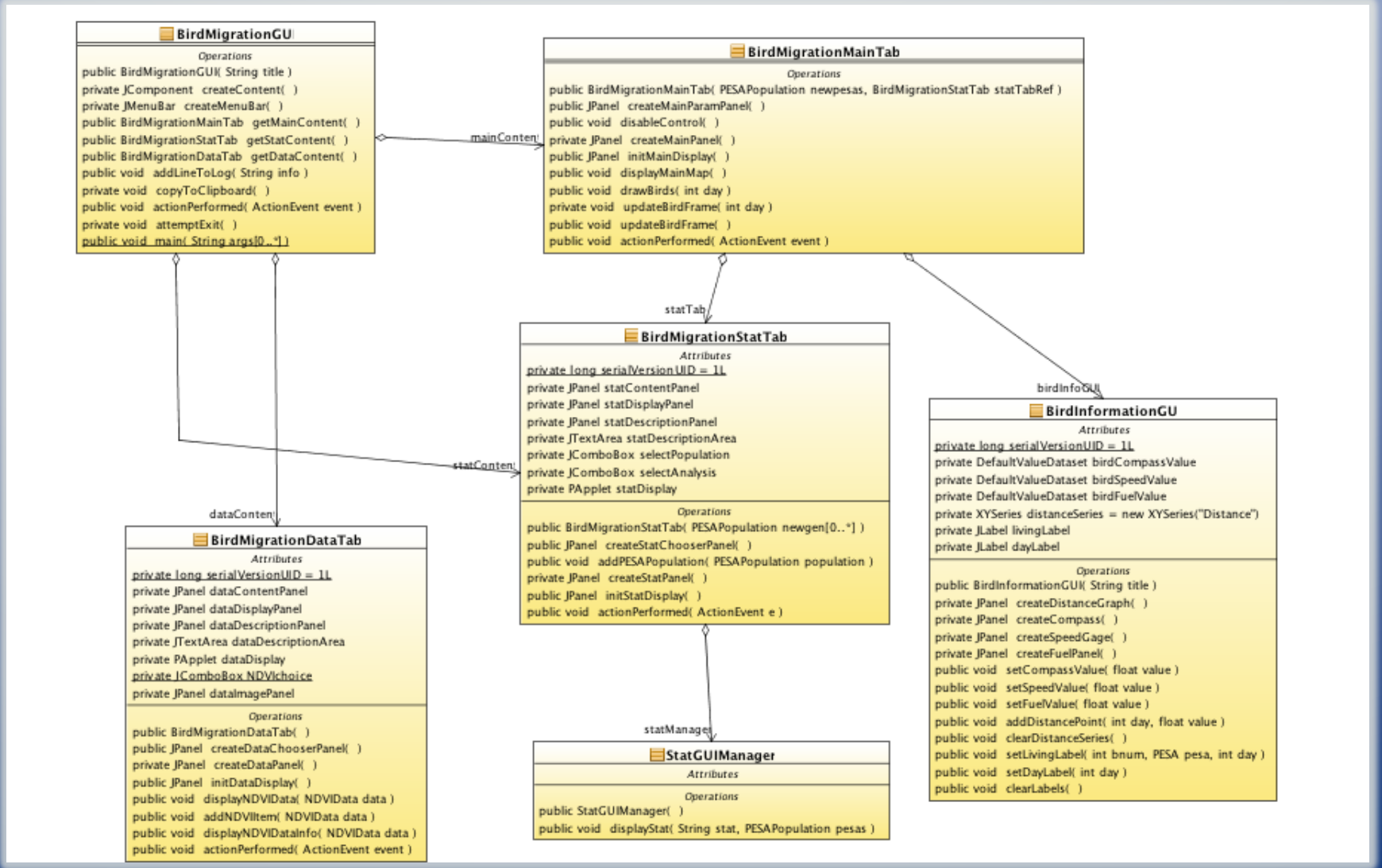
Refactoring ….. Fancy word for

“ Back to Square One “

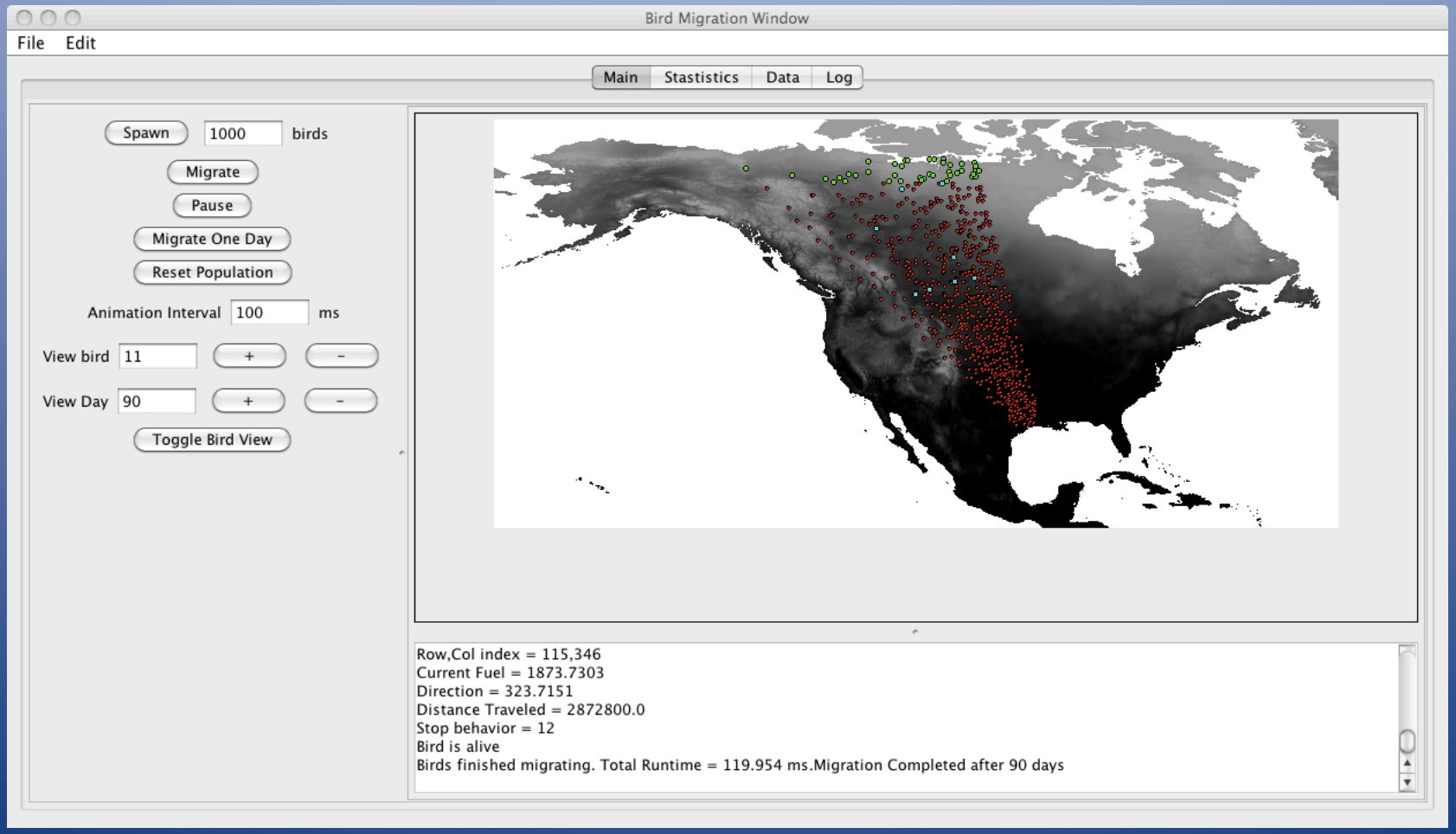
Outline

- The remodeling project
- Diagnostics for climate change impacts and management/conservation
- Hardware acceleration with GPGPUs
- Wrap-up

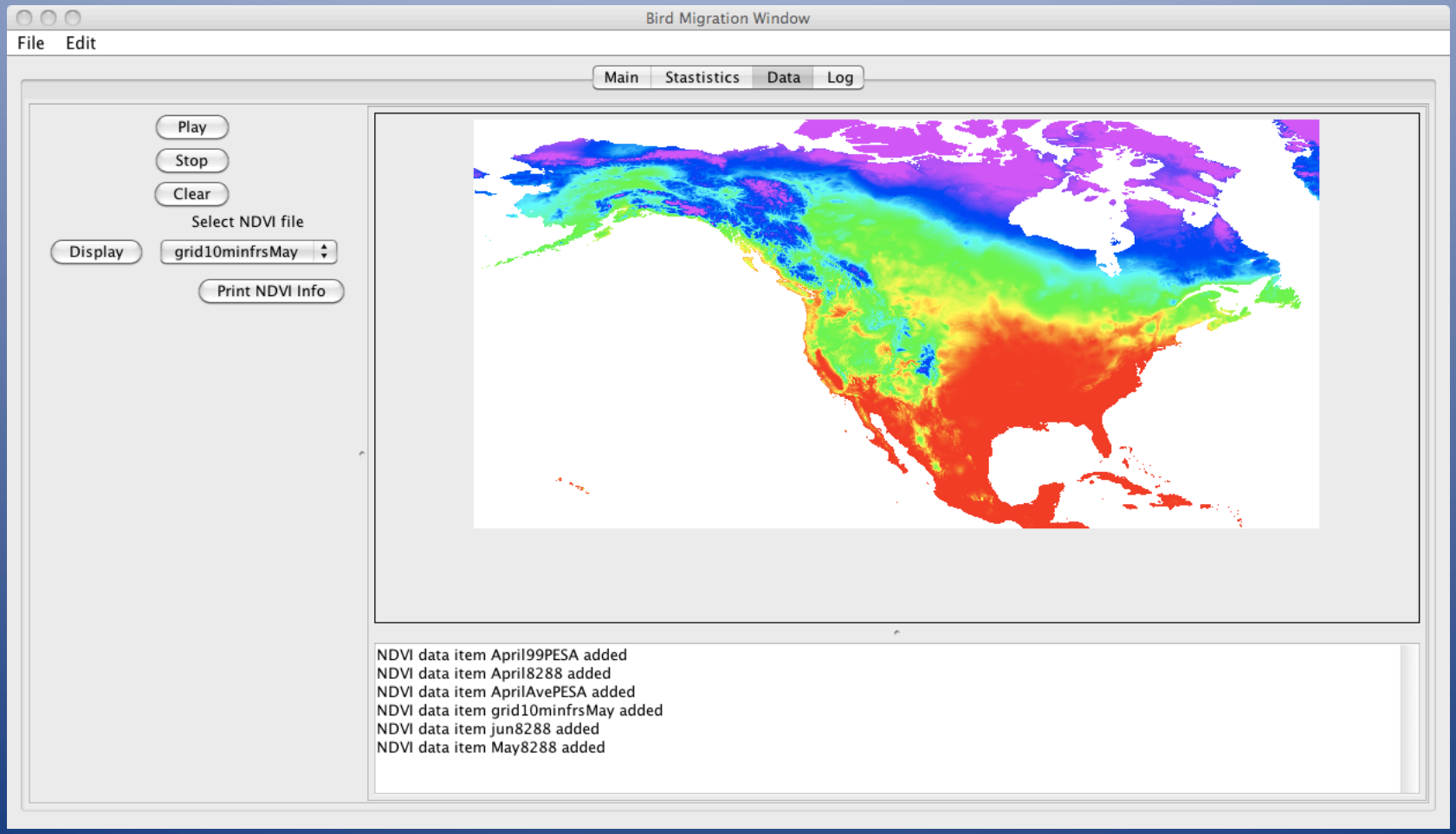
Remodeling Project



A Tool for Studying Bird Migration Under Climate Change

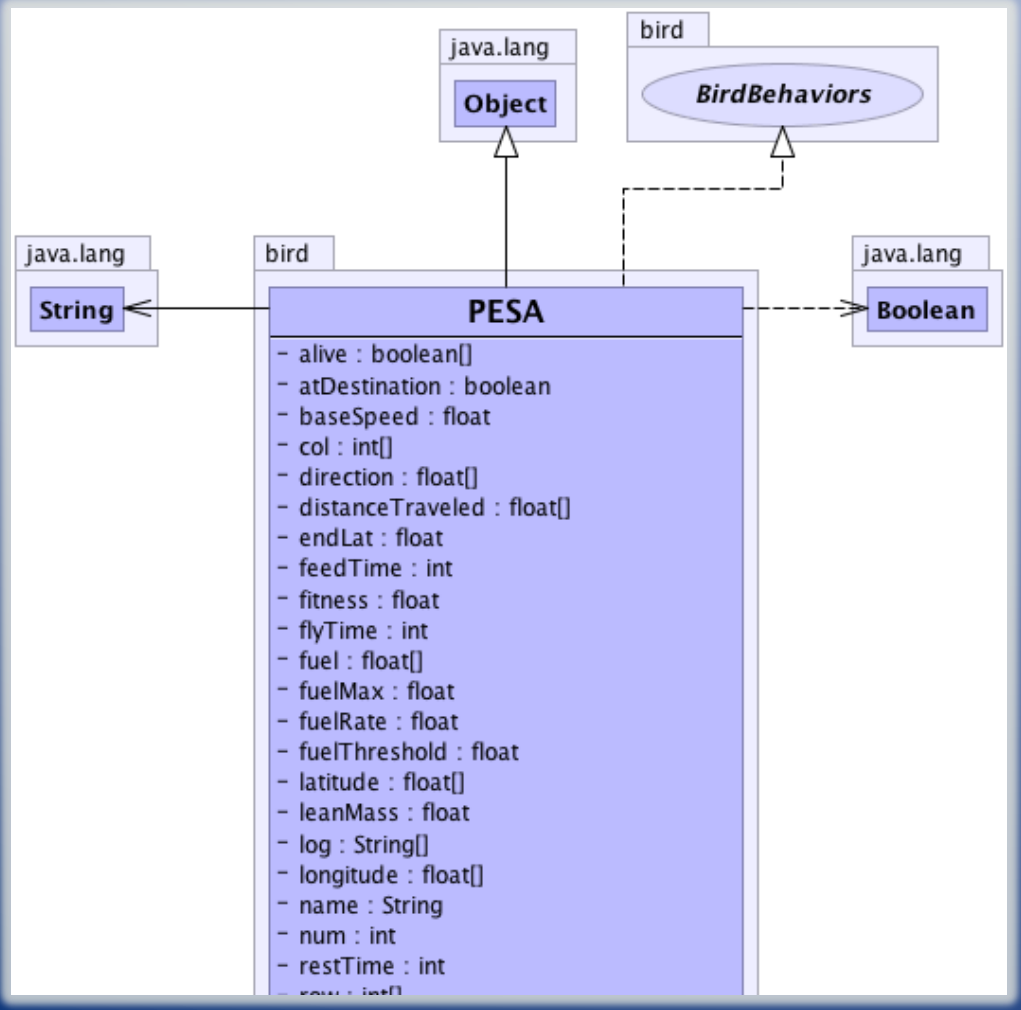


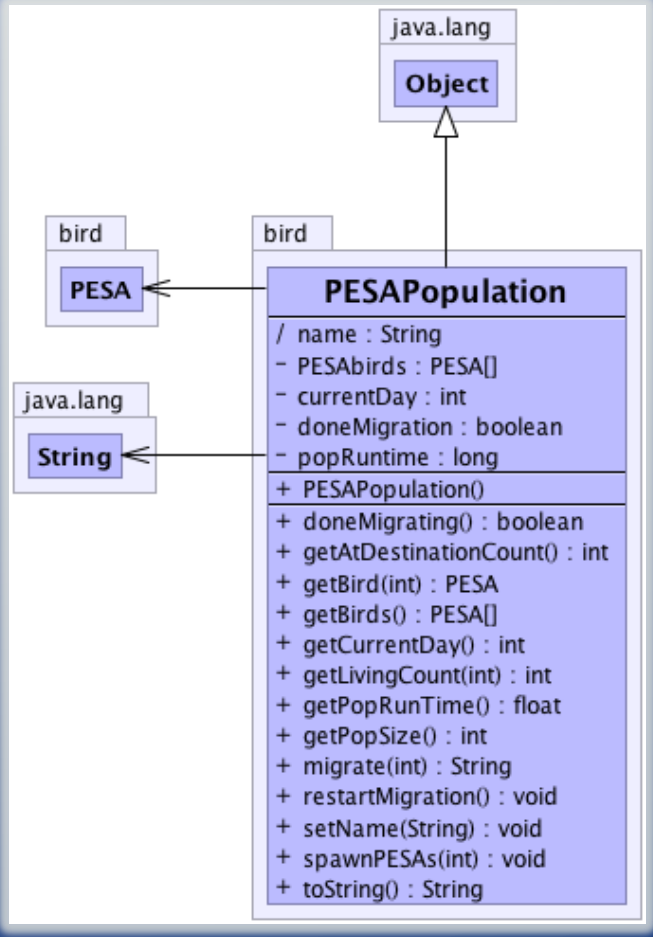
Input Data Layer-Spatial distribution of frost free days in May



(Example layer)

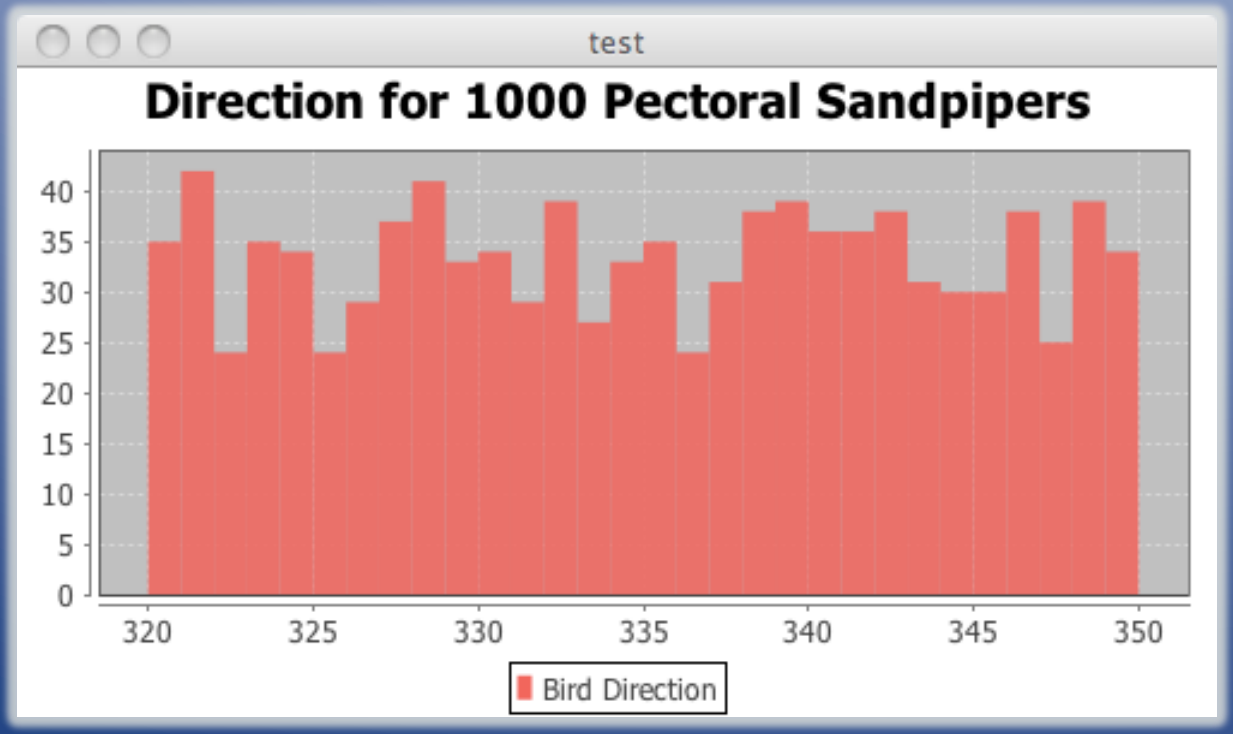
Model-View-Controller

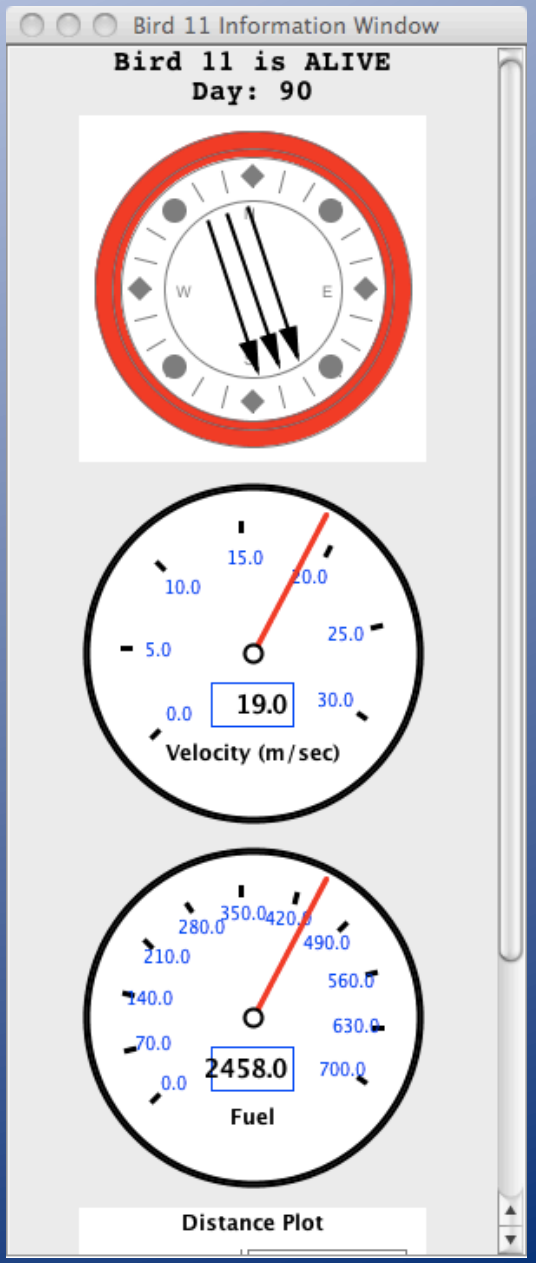




Diagnostic Outputs

(State Variables)





Recasting Observables

North American Bird Conservation Regions

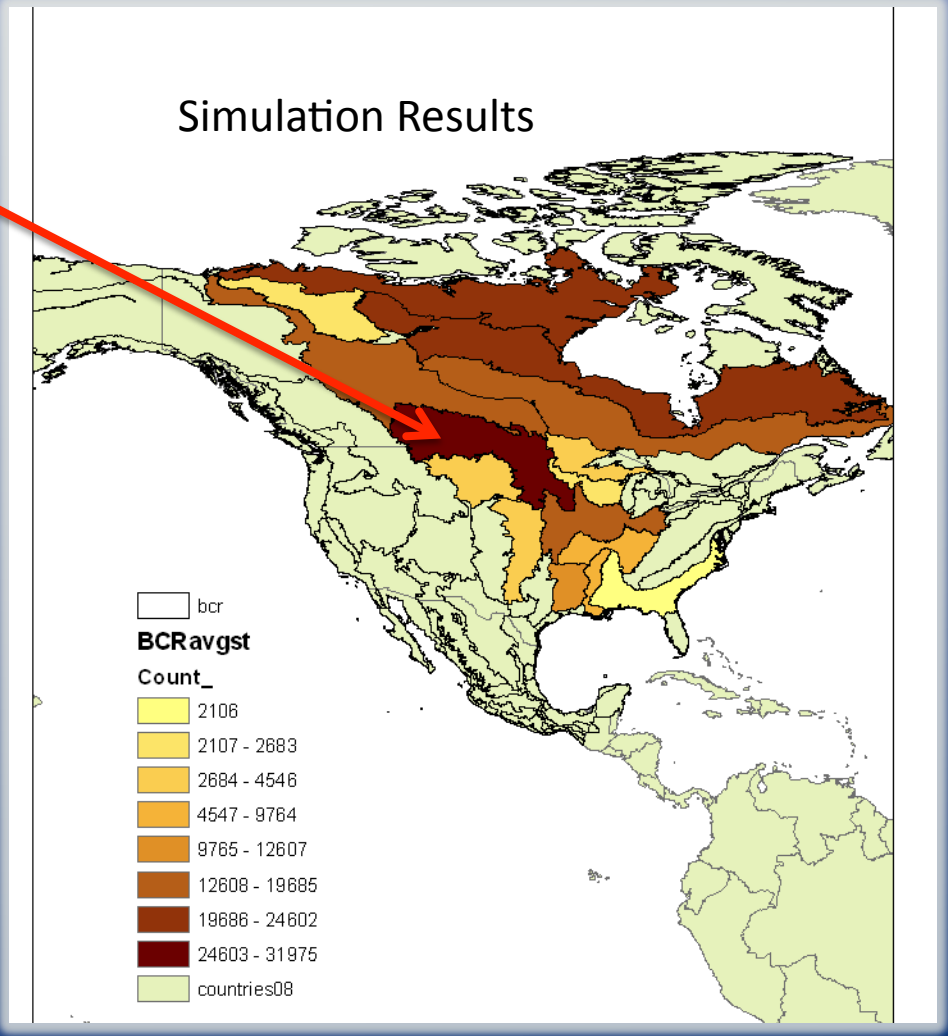
January through June (Maximum count totals = 55,205)			
Maximum Count	Latitude (°N)	Longitude (°W)	Location
18700	38.30	98.80	Cheyenne Bottoms Wildlife Management Area, Kansas
3018	44.70	97.00	Dry Lake B, Clark County, South Dakota
1928	29.90	95.90	Rice fields, Harris County and Waller County, Texas
1500	41.80	91.50	Coralville Reservoir, Johnson County, Iowa
1500	29.30	89.90	Grand Terre, Jefferson Parish, Louisiana
1500	40.70	95.60	Riverton Wildlife Area, Fremont County, Iowa
1087	29.10	95.20	Brazoria National Wildlife Refuge, Brazoria County, Texas
1000	27.80	97.40	Corpus Christi, Texas
1000	39.40	91.10	Ted Shanks Wildlife Area, Missouri
1000	44.40	95.30	Redwood County, Minnesota
1000	53.30	112.50	Beaverhill Lake, Alberta
1000	34.70	91.90	Anderson's Fish Hatchery, Lonoke County, Arkansas
858	29.70	94.60	Chambers County, Texas
833	44.70	97.70	Pond near Dry Lake, Clark County, South Dakota

NABCI
US Shorebird Conservation Plan
USFWS survey data
Bird Phenology Network

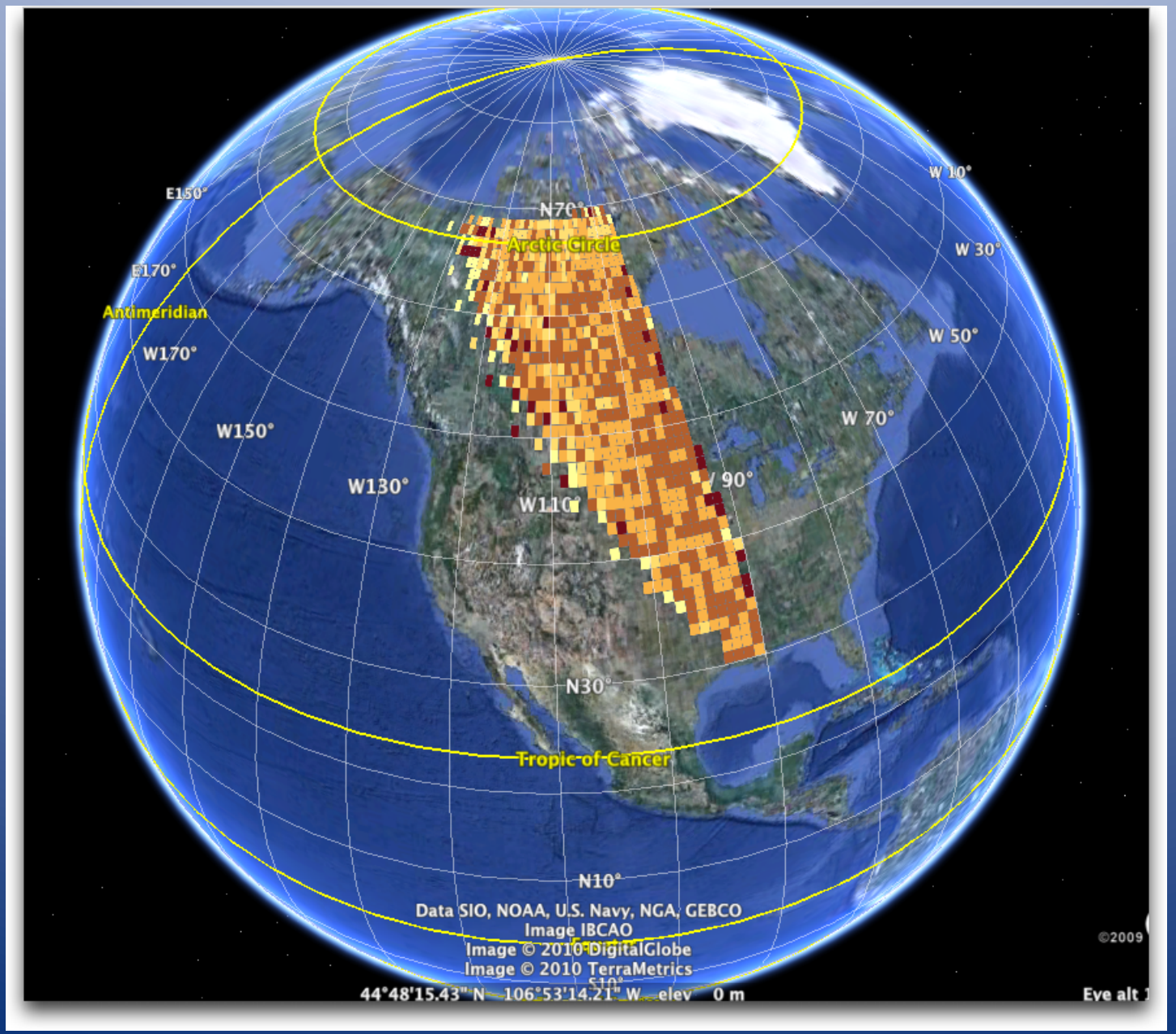
Pectoral Sandpiper summarized by Bird Conservation Regions

Prarie Pot Hole Region

Simulation Results

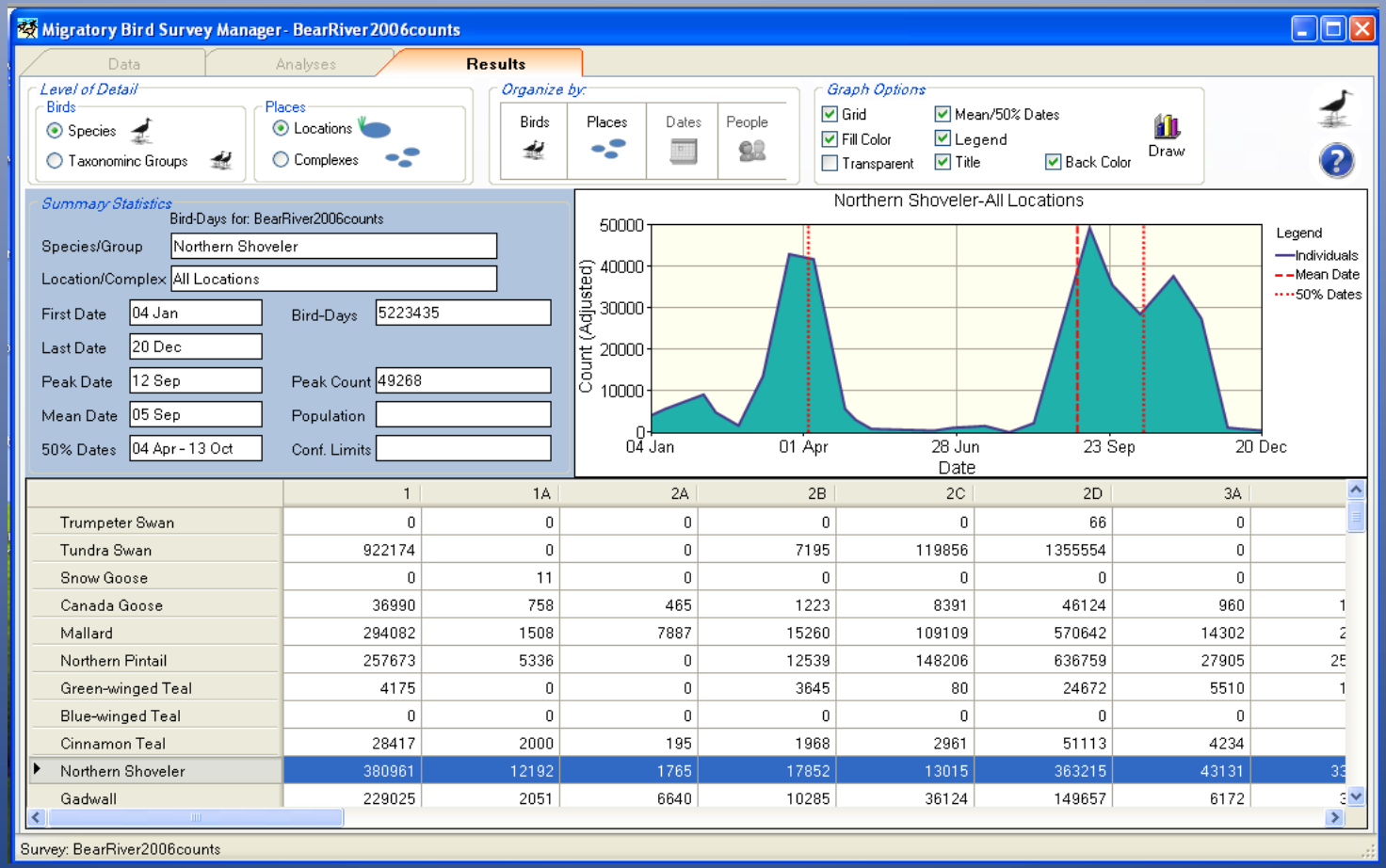


Stop-over stays summarized in 1 x 1 deg lat -long



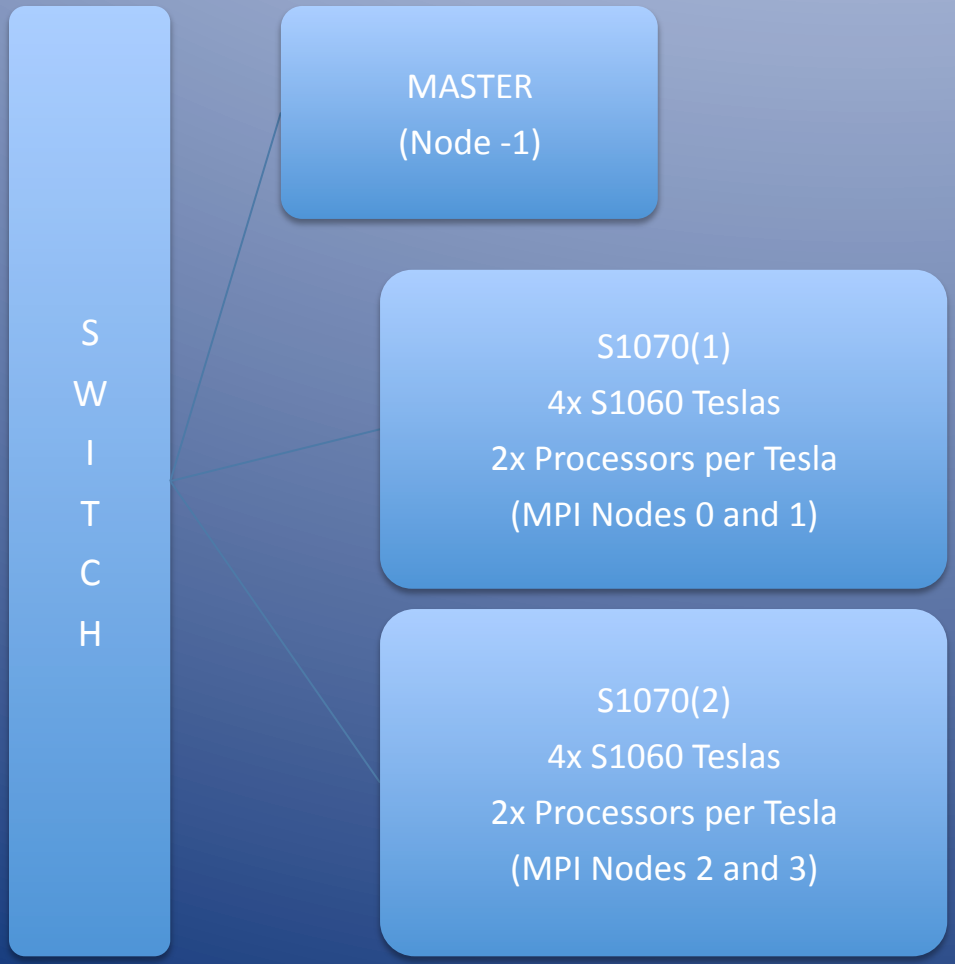
Adrian Farmer

Survey Application



	1	1A	2A	2B	2C	2D	3A	
Trumpeter Swan	0	0	0	0	0	66	0	
Tundra Swan	922174	0	0	7195	119856	1355554	0	
Snow Goose	0	11	0	0	0	0	0	
Canada Goose	36990	758	465	1223	8391	46124	960	1
Mallard	294082	1508	7887	15260	109109	570642	14302	2
Northern Pintail	257673	5336	0	12539	148206	636759	27905	25
Green-winged Teal	4175	0	0	3645	80	24672	5510	1
Blue-winged Teal	0	0	0	0	0	0	0	
Cinnamon Teal	28417	2000	195	1968	2961	51113	4234	
Northern Shoveler	380961	12192	1765	17852	13015	363215	43131	33
Gadwall	229025	2051	6640	10285	36124	149657	6172	3

Penguin-Tesla 8 TFLOP Workgroup GPU Compute Cluster



- Use MPI/CUDA hybrid to utilize every GPU in cluster
  - Use rank to bind single GPU for 1 processor on a node
  - 240 cores per GPU
  - 1920 cores in entire cluster

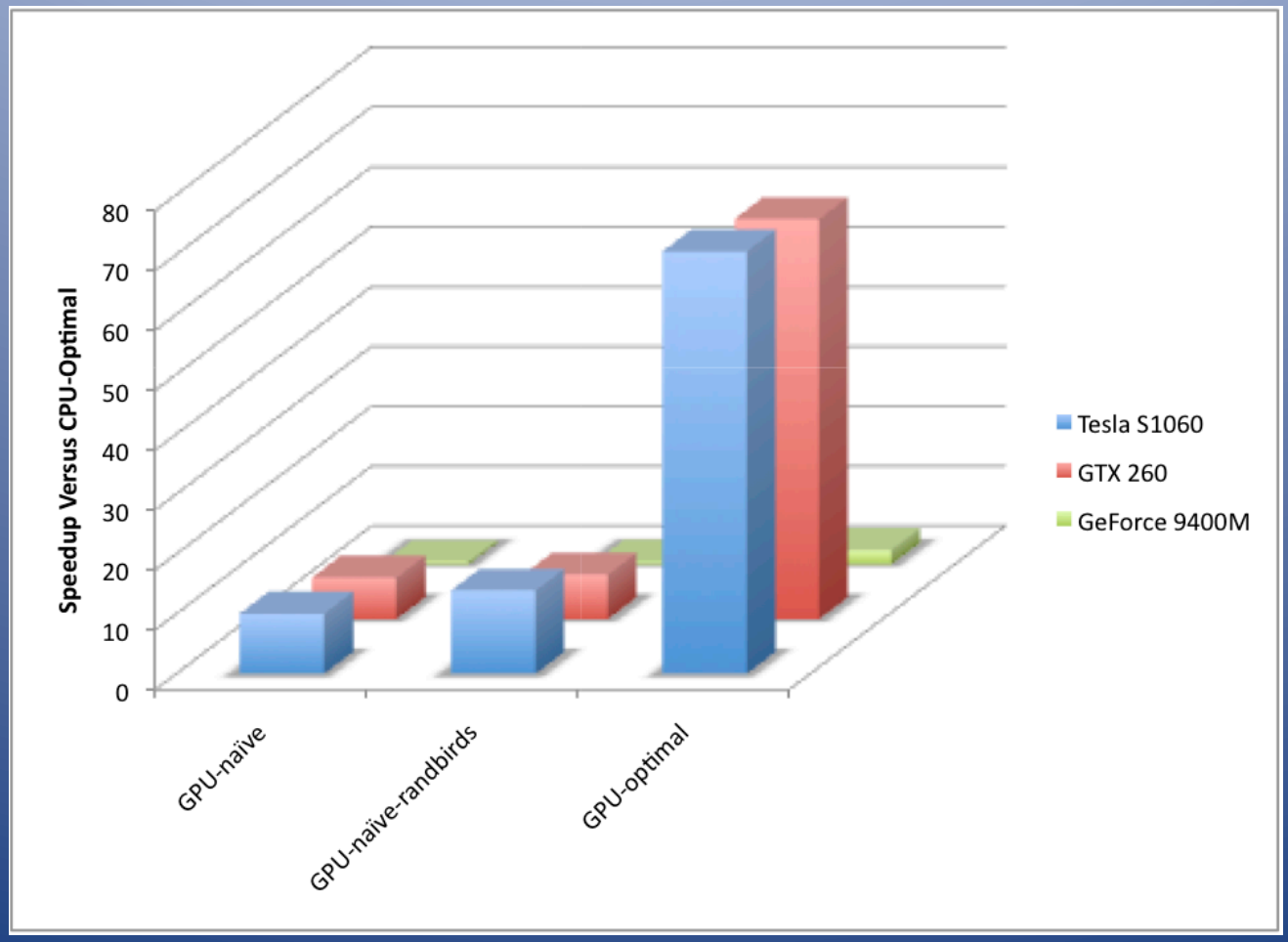
“First Light”

Baseline Parallel Implementation

- 1,024,000 birds
- Laptop integrated card (16 cores)
  - Average 89.92 (ms)
  - Total 1798.474854 (ms)
    - 5.45x faster than unoptimized
    - 2.2x faster than cache optimized
- Desktop GTX 260 (216 cores)
  - Average 3.82 (ms)
  - Total 76.470993 (ms)
    - 113.96x faster than unoptimized
    - 45.95x faster than cache optimized

(Tim Blattner)

Optional Hardware Acceleration



(Tim Blattner)

Summary

- Model totally reworked and revamped
- Parallel implementation of key routines
- Model-View-Controller abstraction

Predator-prey
Problem domain size
Tailored application views

Creating Observables used for

- Convergence of evidence tests
- Diagnostics for climate change change impacts
- Management-Conservation-Public (USFWS/BCR)

45,000,000 Bird Watchers