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GEO 565 Spatial Analysis Final Project

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Biotic and Abiotic Associations of the Federally Endangered June Sucker (*Chasmistes liorus*) in Utah Lake, UT, USA

Introduction

Utah Lake is an extremely large (~96,000 acres) lake located in north-central Utah. It is however, a rather featureless lake. Maximum depth is only 14 feet and average depth is 9 feet. The dominant substrate is mud although there are limited areas of rocky near-shore zones. Most of the lake is devoid of vegetation as a result of high density of common carp (*Cyprinus carpio*). Carp comprise approximately 90% of the biomass of the lake. There are dense stands of emergent vegetation, predominately phragmites and bulrush, which rim the lake from shoreline to an average of 100 to 200 meters from shore, although vegetative coverage can extend over 1500 meters from shore in the bays (Crowl et al 1998b).

Utah Lake was once home to twelve species of native fish, including the Utah Lake strain of Bonneville cutthroat trout (*Onchorhynchus clarkii utah*) and the now endangered June sucker (*Chasmistes liorus*). Of the original fish species inhabiting the lake, only the June sucker, Utah sucker (*Catostomus ardens*) and Utah chub (*Gila atraria*) are currently found in the lake. The latter two species are common outside of Utah Lake and are of lesser conservation concern. The lake is currently dominated by non-native species such as common carp, white bass (*Morone chrysops)*, channel catfish (*Ictalurus punctatus)*, black bullhead *(Ameirus melas)*, and walleye (*Sander vitreus)* (Landress and Watson 2009). The June sucker is endemic to Utah Lake and a

1988 study estimated the population to be between 300 and 1100 individuals. The species was listed as federally endangered in 1986 (Keleher et al 1998).

Biological research and monitoring in Utah Lake has greatly increased in the past four years. Sampling effort of the fish community by trap nets from 2007 to 2010 was quadrupled compared to prior years. This effort has resulted in a rich data set of June sucker captures as well as information regarding the overall non-native fish community. In addition to standardized systematic trap net monitoring, additional sampling has been conducted with trammel nets to target June sucker near the mouths of tributaries as they stage for their spawning runs in the late spring. Also, a large-scale effort to remove carp from Utah Lake was initiated in 2008 to mitigate the damaging effects the invasive fish has to the vegetation of the lake. This commercial fishing effort provides the Utah Division of Wildlife Resources (UDWR) the ability to sample large quantities of fish in areas not typically sampled, and in colder weather when trap and trammel nets cannot be utilized, as the commercial fisherman has a method of seining underneath the ice that covers the lake from December to March (Landress and Watson 2009). Furthermore, a captive breeding program for June sucker was developed with the initiation of the recovery program. In the first decade of its existence only approximately 20,000 June sucker, largely plagued by hatchery-induced growth abnormalities, were reintroduced in the lake. Since 2007, over 100,000 larger and healthier June sucker have been reintroduced (UDWR 2010). Recent sampling data reflect this increase in stocking effort.

Purpose and Need

An extremely large amount of data associated with fish collections has been accumulated in Utah Lake, particularly in the past few years. From 2007 to 2010, 26,342 fish and associated

habitat variables were collected by UDWR biologists. However, a spatial analysis of this data has not been conducted. The purpose of this spatial analysis is to determine patterns of June sucker use of Utah Lake as well as patterns of the non-native fish of the lake which could have impacts on June sucker. Very little is known of the life history of this species particularly concerning in-lake behavior. June sucker "stage," or congregate at the mouths of tributaries in late spring before commencing their spawning run in early summer. They then return to the lake where their behavior is largely unknown for the majority of the year (Shirley 1983). Therefore, there is a need to begin to analyze spatial and temporal patterns of June sucker captures within the lake. Additionally, predatory species such as white bass, walleye, and channel catfish have been implicated in the lack of June sucker juvenile recruitment to the population (USFWS 1999). A spatial and temporal analysis of these species has also been neglected.

The purpose of this project is to determine spatial clustering of June sucker in Utah Lake and if there are associated biotic or abiotic variables. June sucker will be assessed as a population, by size class, and by gender. Spatial patterns of other key species will be addressed, particularly if there are potential negative effects associated with June sucker.

The base data, fish and habitat, for this project are found in a Microsoft Access database stored in the UDWR network.

Collecting Field Data

Data used in this analysis were collected by UDWR personnel from February 2007 to August 2010. At each sampling location a Garmin etrex C handheld GPS unit was used to record UTM's. For each site, depth (to the nearest decimeter), substrate (mud, sand, gravel, cobble, etc), temperature (degrees Celsius), vegetation type, gear type, and set date and time

were recorded. For all fish captured, species and length were recorded. For June sucker captures, length and weight were recorded. Additionally, June sucker receive a sub-dermal passive integrative transponder (PIT) tag with a unique code which allows for tracking of individual movement, survival, and growth. Each individual is scanned for a prior tag, receives a new tag if necessary, sex is determined and sexual readiness or "ripeness" is determined.

Analysis

Objective #1: Determine if clustering of June sucker in Utah Lake is occurring, and if so, where.

Objective #2: Determine if June sucker congregate based on size, sex, or seasonality.

Objective #3: Determine if other key species of interest (e.g. walleye, white bass, channel catfish) congregate in a spatially or temporally significant manner that may have biological significance concerning June sucker recruitment.

Data Files

Coverages:

"NAIP2006_Utah.sid" renamed "Aerial_2006" (source: Utah Geological Survey)

Shapefiles:

"allfish" layer adapted from Access database (source: Utah Division of Wildlife)

All other layers were developed or created from this initial layer.

Process

Initial Steps:

Step 1

The first step in this analysis was to query the Access database where the UDWR houses fish capture data. A "select query" was run on all fish captured and sample site data in Utah Lake from 2007 to 2010. These where then converted using a "make table query."

Step 2

OLE DB connection must be established:

- Double-click Database Connections in the ArcCatalog tree.
- Double-click Add OLE DB Connection.
- Navigate to Access database.
- Click Next or click the Connection tab.
- Click Test Connection, then OK
- Import tables from step 1 and save as layer files ("allfish" and "sample_sites")

Step 3

Create the layers to be used in the spatial analyses:

- Open attribute table of "allfish" layer
- Click "options" > "select by attributes"
- In SQL window double-click "speciescod" "=" "skjn" to select all June sucker in the "allfish" layer

- “options” > “export”
- Rename output table “suckers”
- Click on source tab
- Right click on “carp” table and select “display xy data”

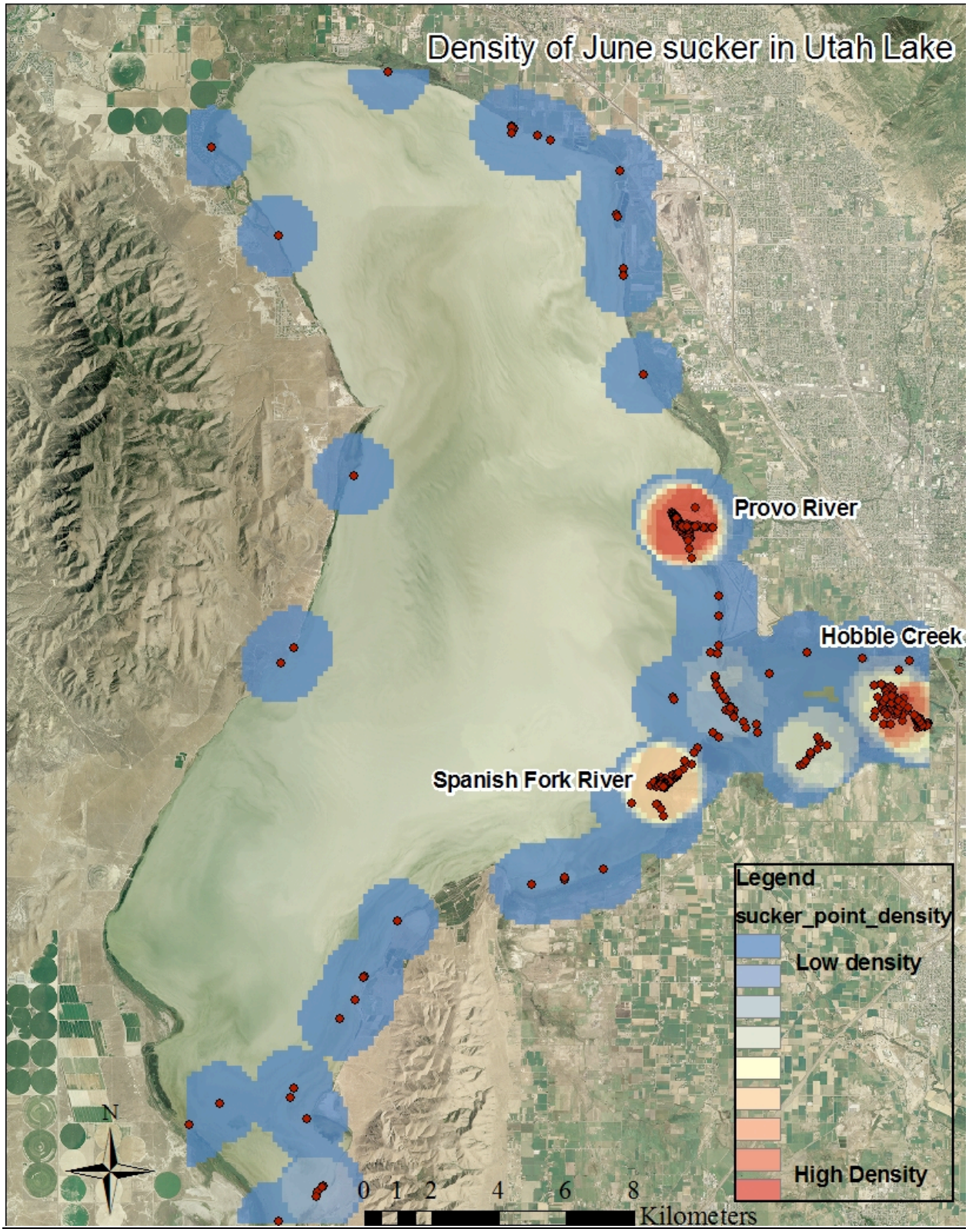
Repeat the above steps for other species of interest and label appropriately.

Objective # 1: Determine if clustering of June sucker in Utah Lake is occurring, and if so, where.

Steps

- Open ArcToolbox > click “Spatial Analyst Tools” > click “Density” > select “Point density tool”
- Input point features, select “suckers” layer
- Population field “none”
- Output cell size 150
- Neighborhood, select “circle”
- Radius 730, check “map” > “ok”
- “properties” > “symbology” > “classify” > “exclusion” > “excluded values, type “0”
- Change color ramp
- Results: Map 1

Map 1


Density of June sucker in Utah Lake
Provo River
Hobble Creek
Spanish Fork River
Legend
sucker_point_density
Low density
High Density
N
0 1 2 4 6 8
Kilometers

Objective #2: Determine if June sucker congregate based on size, sex, or seasonality.

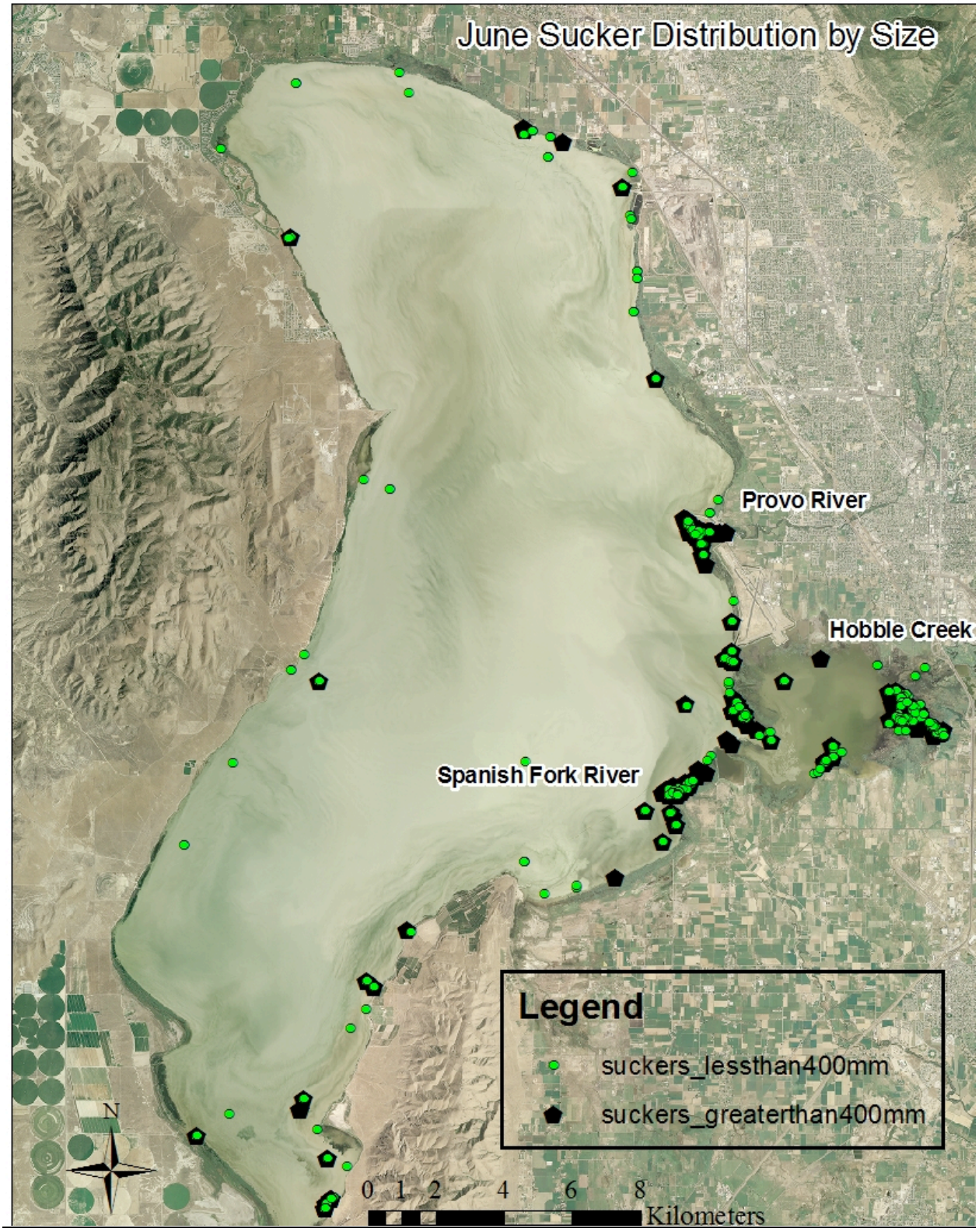
Step 1

- Create new layers from "suckers" layer based on size and sex
- "Select by attribute" for "sex" = "M" and "create new layer from selection", this results in all male June sucker
- "Select by attribute" for "sex" = "F" and "create new layer from selection", this results in all female June sucker
- Results, Map 2
- "Select by attribute" for "length" > "400" "create new layer from selection", this results in all large, reproductively mature June sucker
- "Select by attribute" for "length" <= "400" and "length" >= "200" "create new layer from selection", this results in smaller, non-reproductively mature June sucker
- Results, Map 3

Map 2

June Sucker Distribution by Sex
Provo River
Hobble Creek
Spanish Fork River
Legend
sucker_females
sucker_males
N
0 1 2 4 6 8
Kilometers

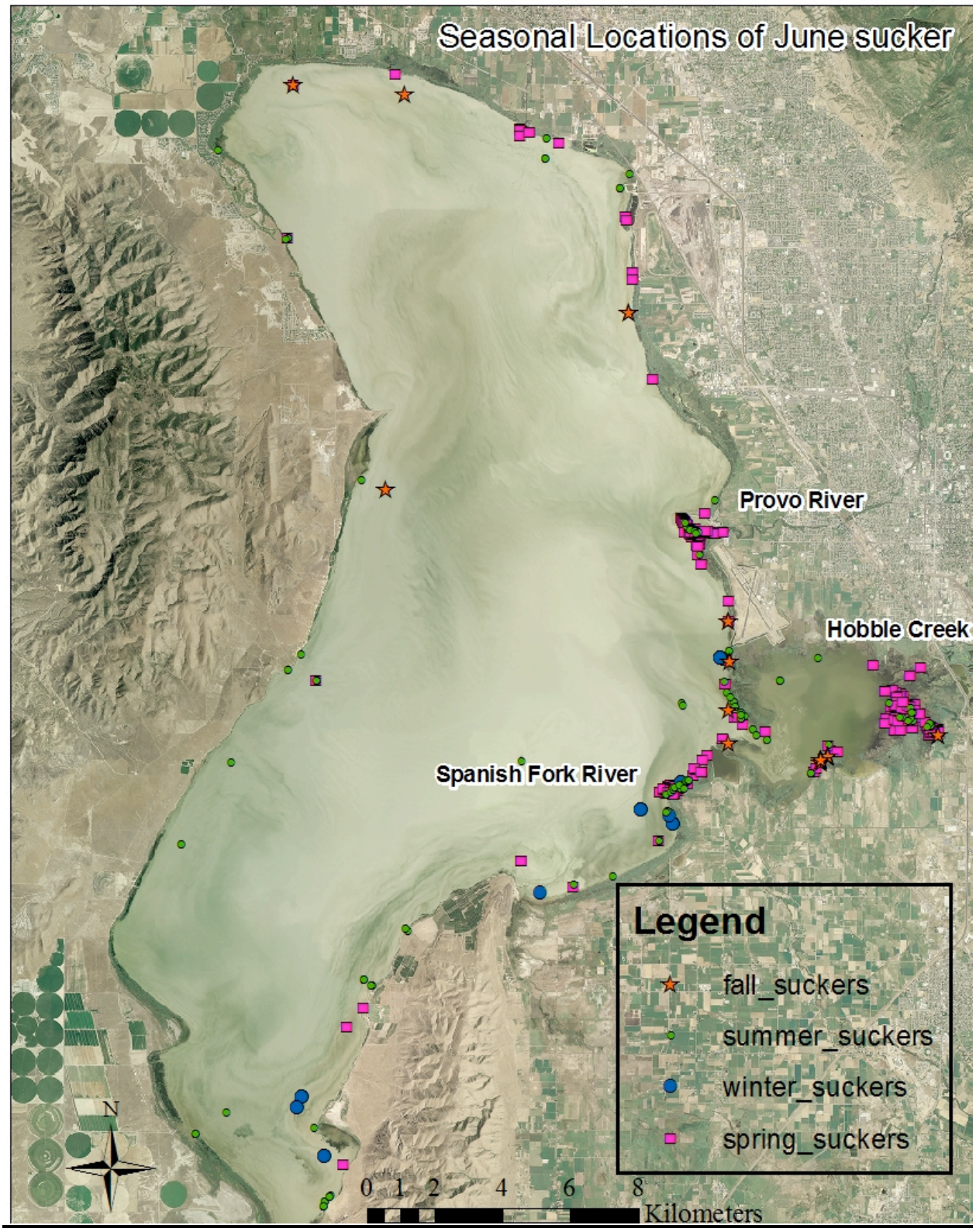
Map3


June Sucker Distribution by Size
Provo River
Hobble Creek
Spanish Fork River
Legend
suckers_lessthan400mm
suckers_greaterthan400mm
N
0 1 2 4 6 8
Kilometers

Step 2

- In order to create new layers for seasonality of sucker occurrence, manipulation of the data must occur since the date field is in the format 09/22/2008 and needs to be organized by month in order to query by seasonality
- "allfish" > attribute table > options > add field > right click on "year" field > field calculator > "year" = "Right([Setdate],4)", this results in a column with only the year.
- "allfish" > attribute table > options > add field > right click on "month" field > field calculator > "month" = "Left ([Setdate], 1)", this results in the assignment of a single digit for each month
- Since some months have two digits (i.e. October – December), select these months in "allfish" " > attribute table > options > add field > right click on "month" field > field calculator > "month" = "Left ([Setdate], 2)", this results in the assignment of a double digit for these months
- Now, create new layers using the new columns for month and year to represent seasonality. Select by attributes > "month >= 4 and month <=6" for spring, etc., then select by attributes > "speciescod" = "skjn" for June sucker for that particular season
- Results Map 4:

Map 4


Seasonal Locations of June sucker
Provo River
Hobble Creek
Spanish Fork River
Legend
fall_suckers
summer_suckers
winter_suckers
spring_suckers
N
0 1 2 4 6 8
Kilometers

Objective #3: Determine if other key species of interest (e.g. walleye, white bass, channel catfish) congregate in a spatially or temporally significant manner that may have biological significance concerning June sucker recruitment.

Step 1

- Create new layers representing specific predatory species presence during one season: e.g. "select by attributes" in "summer_allfish" for "SpeciesCod" = "WE" and save as new layer. This results in a layer of walleye occurrence in summer.
- Repeat above steps for walleye in fall, white bass in spring and summer, and channel catfish in spring, summer, and fall.

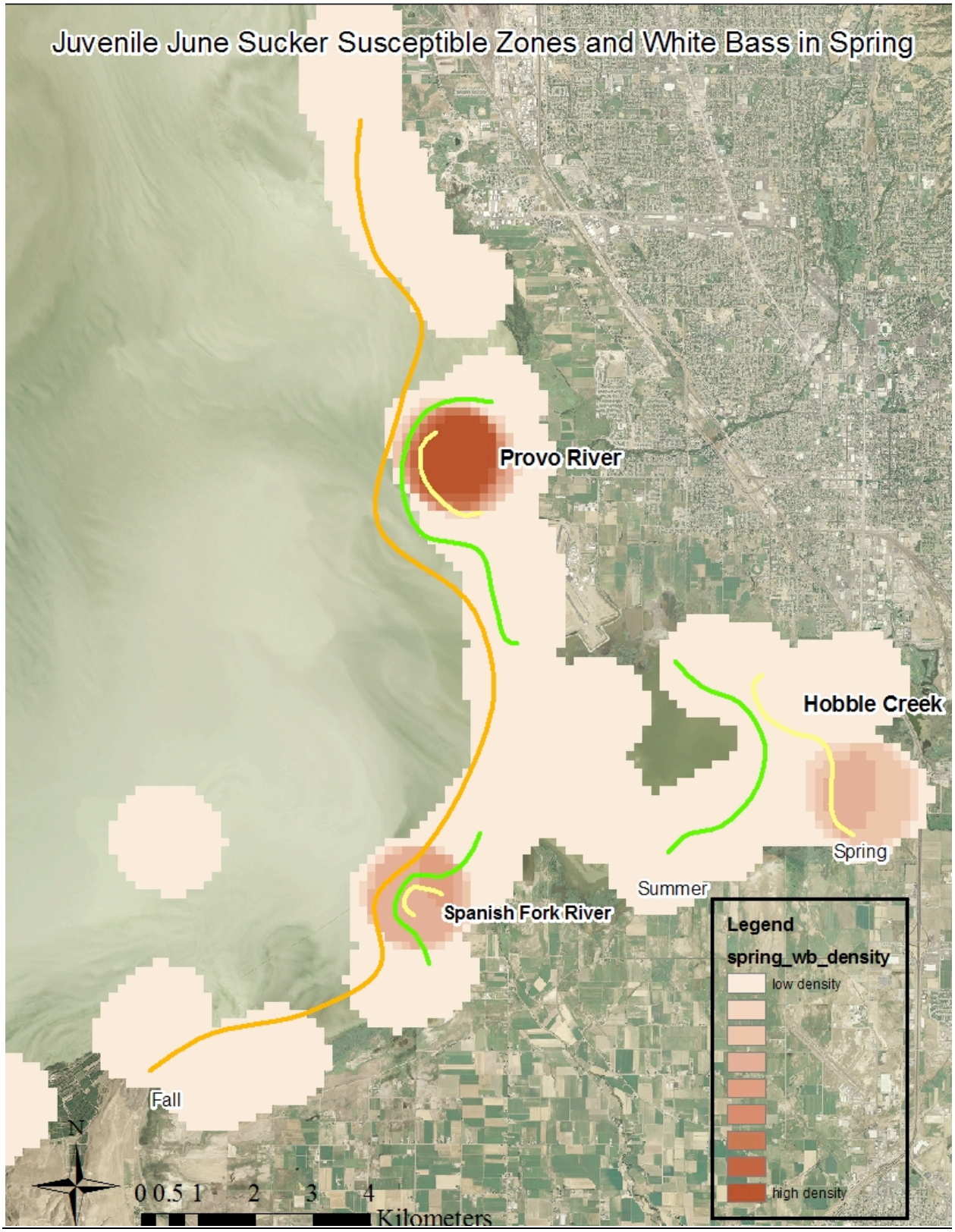
Step 2

- Create rasters of general densities of target predatory species:
- Open ArcToolbox > click "Spatial Analyst Tools" > click "Density" > select "Point density tool"
- Input point features, select "summer_walleye" layer
- Population field "none"
- Output cell size (autofill)
- Neighborhood, select "circle"
- Radius (autofill), check "map" > "ok"
- "properties" > "symbology" > "classify" > "exclusion" > "excluded values, type "0"
- Change color ramp
- Repeat above steps for walleye in fall, white bass in spring and summer, and channel catfish in spring, summer, and fall.

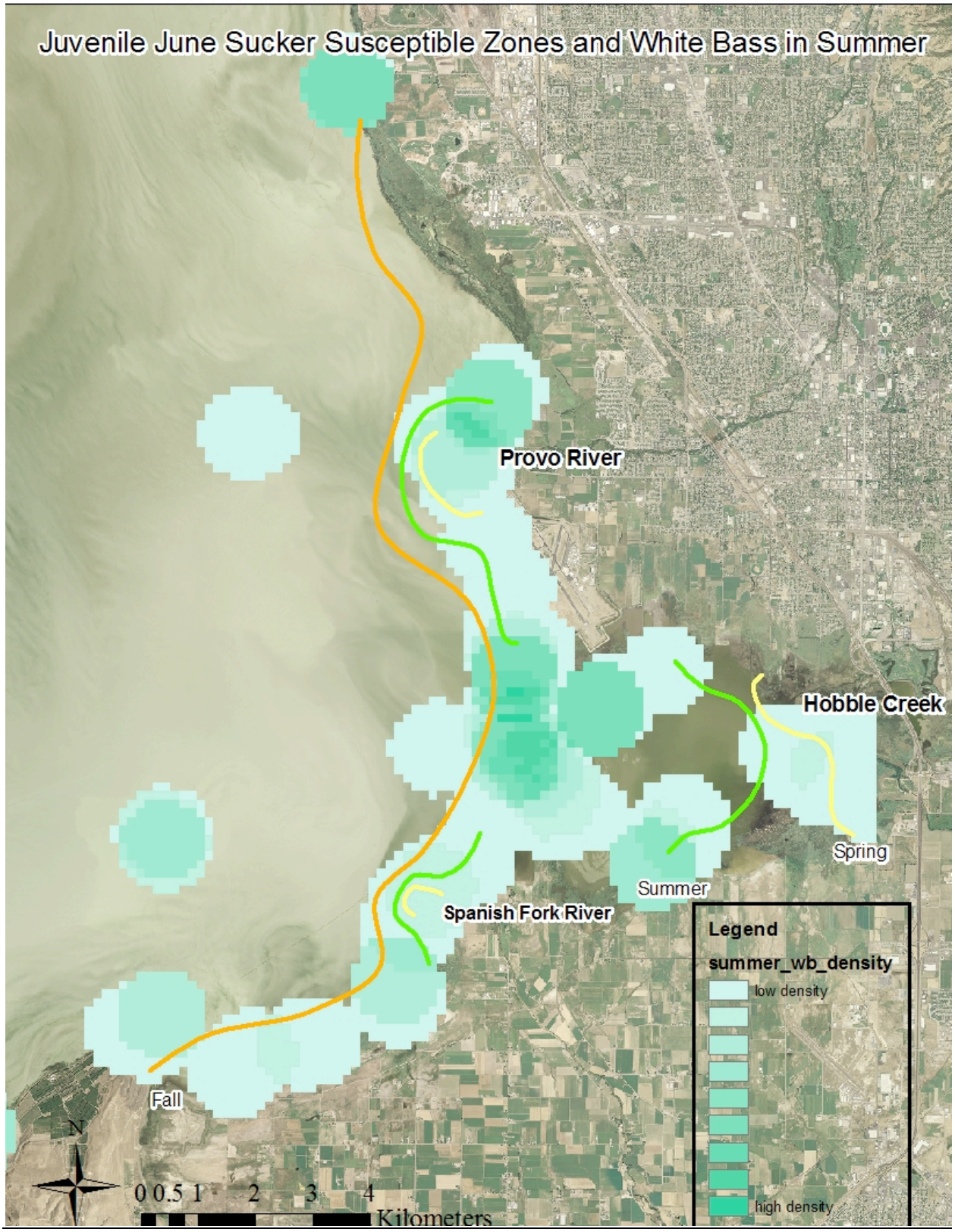
Step3

- Draw lines that approximate the areas of susceptibility for juvenile June sucker in the spring, summer, and fall
- Click “new curve” and draw lines
- Resize lines and color code specific to spring, summer, and fall by double-clicking and editing in the properties dialog box
- Create maps illustrating predatory fish in susceptibility zones
- Results: Maps 5-11

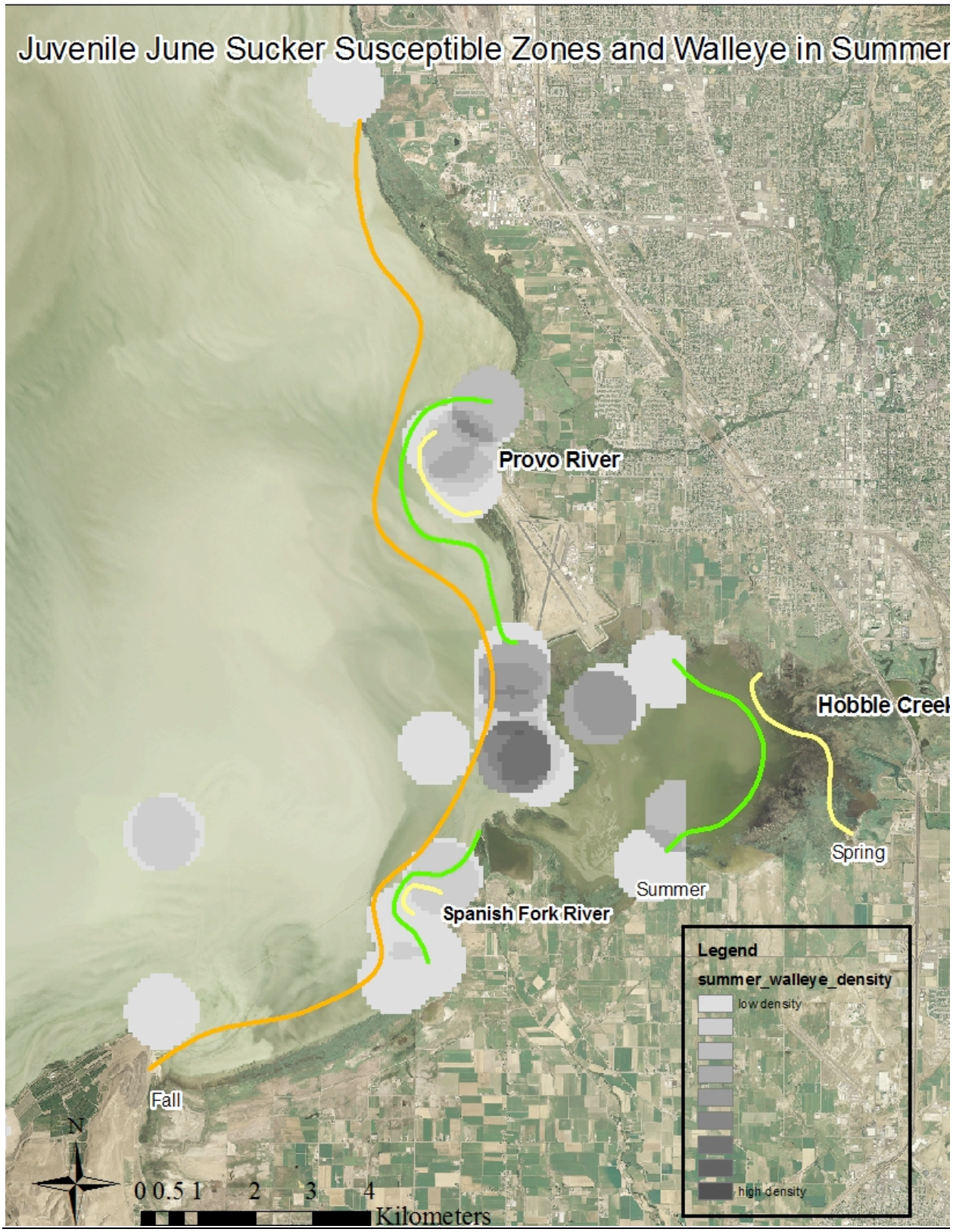
Map 5


Juvenile June Sucker Susceptible Zones and White Bass in Spring
Provo River
Hobble Creek
Spring
Summer
Spanish Fork River
Fall
Legend
spring_wb_density
low density
high density
N
0 0.5 1 2 3 4
Kilometers

Map 6


Juvenile June Sucker Susceptible Zones and White Bass in Summer
Provo River
Hobble Creek
Spring
Summer
Spanish Fork River
Fall
Legend
summer_wb_density
low density
high density
N
0 0.5 1 2 3 4
Kilometers

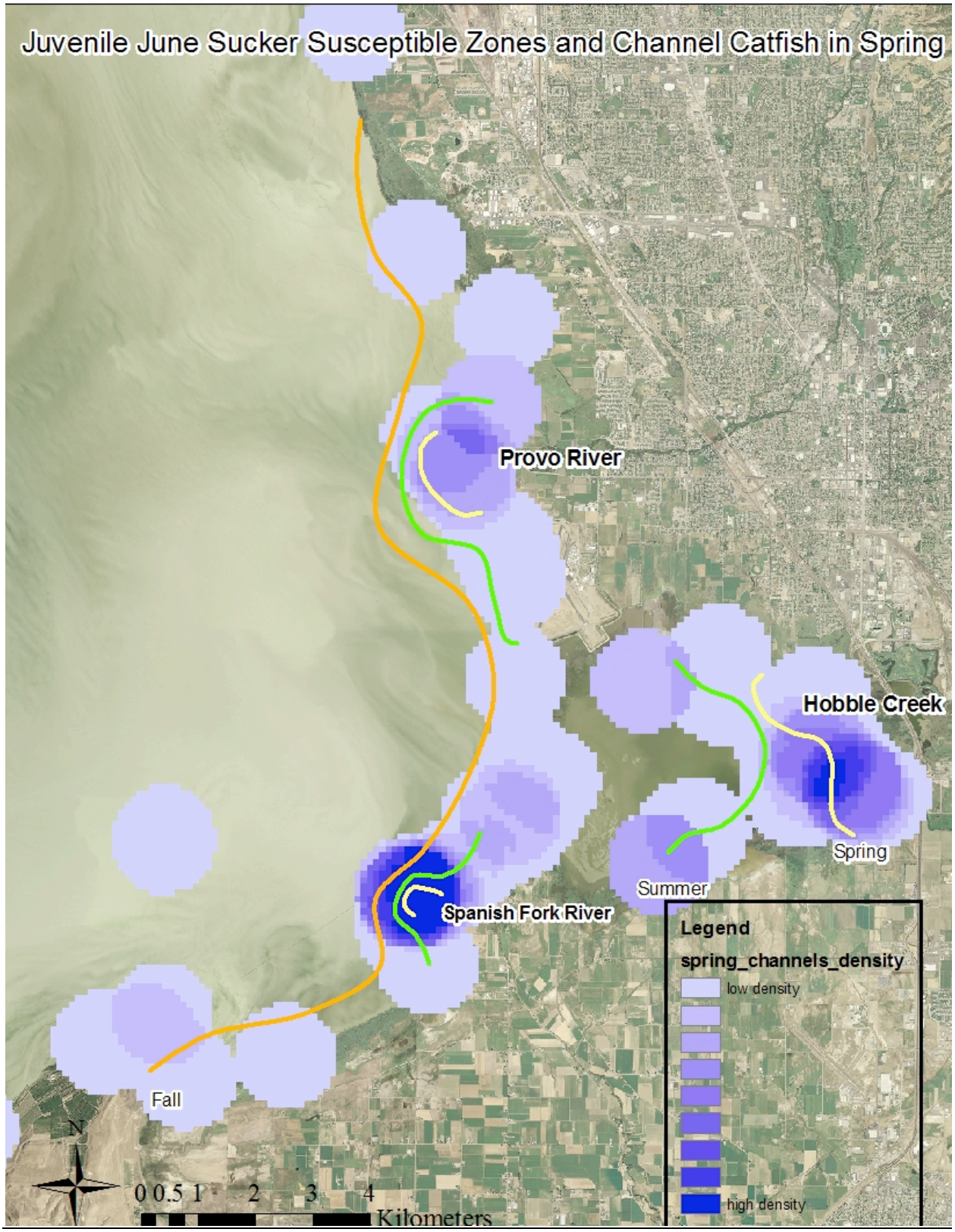
Map 7


Juvenile June Sucker Susceptible Zones and Walleye in Summer
Provo River
Hobble Creek
Spring
Summer
Spanish Fork River
Fall
Legend
summer_walleye_density
low density
high density
N
0 0.5 1 2 3 4
Kilometers

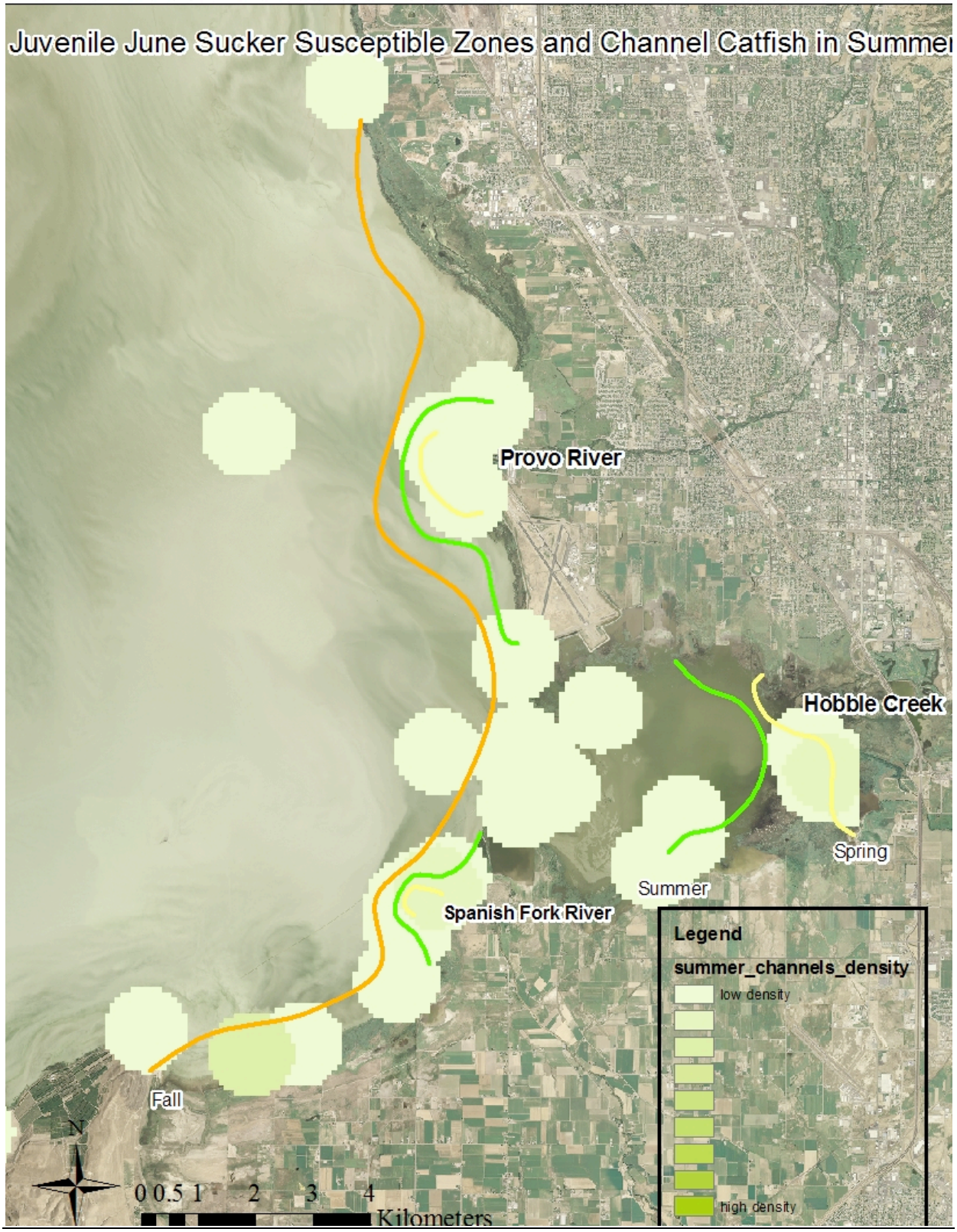
Map 8

Juvenile June Sucker Susceptible Zones and Walleye in Fall
Provo River
Hobble Creek
Spring
Summer
Spanish Fork River
Fall
Legend
fall_walleye_density
low density
high density
N
0 0.5 1 2 3 4
Kilometers

Map 9


Juvenile June Sucker Susceptible Zones and Channel Catfish in Spring
Provo River
Hobble Creek
Spring
Summer
Spanish Fork River
Fall
Legend
spring_channels_density
low density
high density
N
0 0.5 1 2 3 4
Kilometers

Map 10


Juvenile June Sucker Susceptible Zones and Channel Catfish in Summer
Provo River
Hobble Creek
Spring
Summer
Spanish Fork River
Fall
Legend
summer_channels_density
low density
high density
N
0 0.5 1 2 3 4
Kilometers

Map 11

Juvenile June Sucker Susceptible Zones and Channel Catfish in Fall
Provo River
Hobble Creek
Spring
Summer
Spanish Fork River
Fall
Legend
fall_channels_density
low density
high density
N
0 0.5 1 2 3 4
Kilometers

Results and Recommendations

The first objective was to determine if clustering of June sucker was occurring in Utah Lake. As is evidenced in **(Map 1)**, there are five distinct clusters. The three associated with the three largest tributaries of the lake, Provo River, Spanish Fork River, and Hobble Creek were already known. The two additional clusters not associated with a tributary are interesting. Further field investigations should be conducted to determine the potential cause of these congregations (e.g. food supply, underwater springs, etc).

The second objective was to determine if June sucker congregate based on sex, size, or seasonality. There does not appear to be differences in sexual distribution **(Map 2)**. There does appear to be differences in distribution based on size **(Map 3)**. June sucker larger than 400 mm are largely found in the five main congregation areas illustrated in Map 1. These are sexually mature fish which in spawning season would be expected to be found in these areas, but not capturing these larger fish in other areas of the lake the rest of the year is surprising. Fish smaller than 400 mm (sexually immature fish) were found more widely distributed in all sampled areas of the lake. **(Map 4)** illustrates congregations based on season. The spring congregations are due to the spawning behavior of the fish. June sucker are more widely and evenly distributed in summer (post-spawn) and form smaller congregations in the fall. It is difficult to determine winter congregations as sampling was not widely distributed throughout the lake.

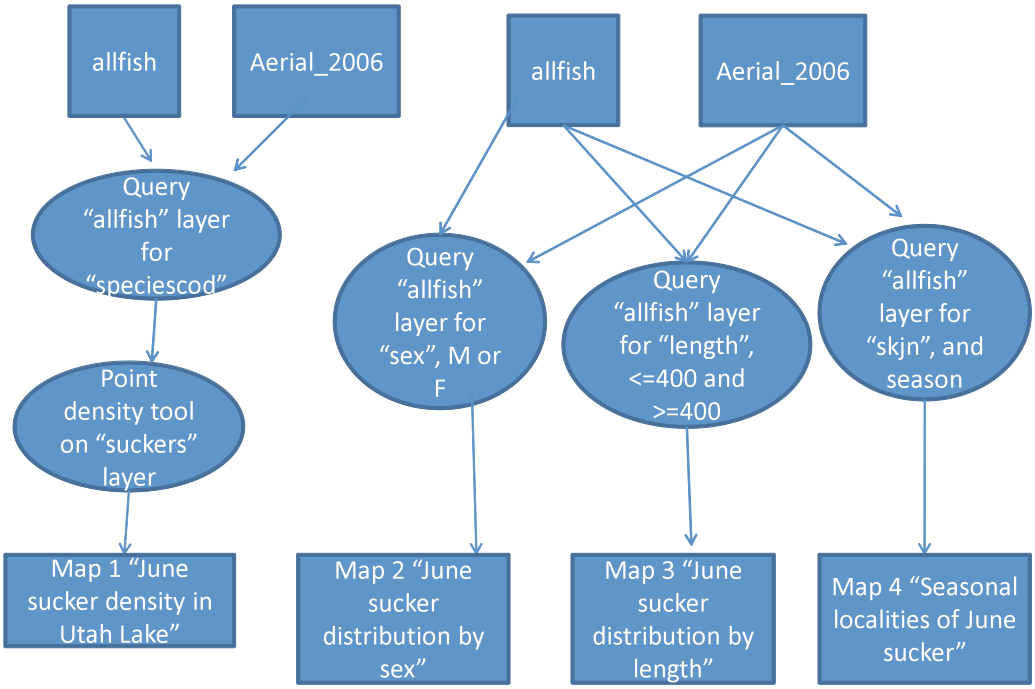
The third objective was to determine if other key species of interest (e.g. walleye, white bass, and channel catfish) congregate in a spatially or temporally significant manner that may have biological significance concerning June sucker recruitment. Zones radiating from the three main tributaries are critical nursery areas for young-of-year June sucker. The presence of predatory fish in these areas could be detrimental to their survival. White bass, a potential

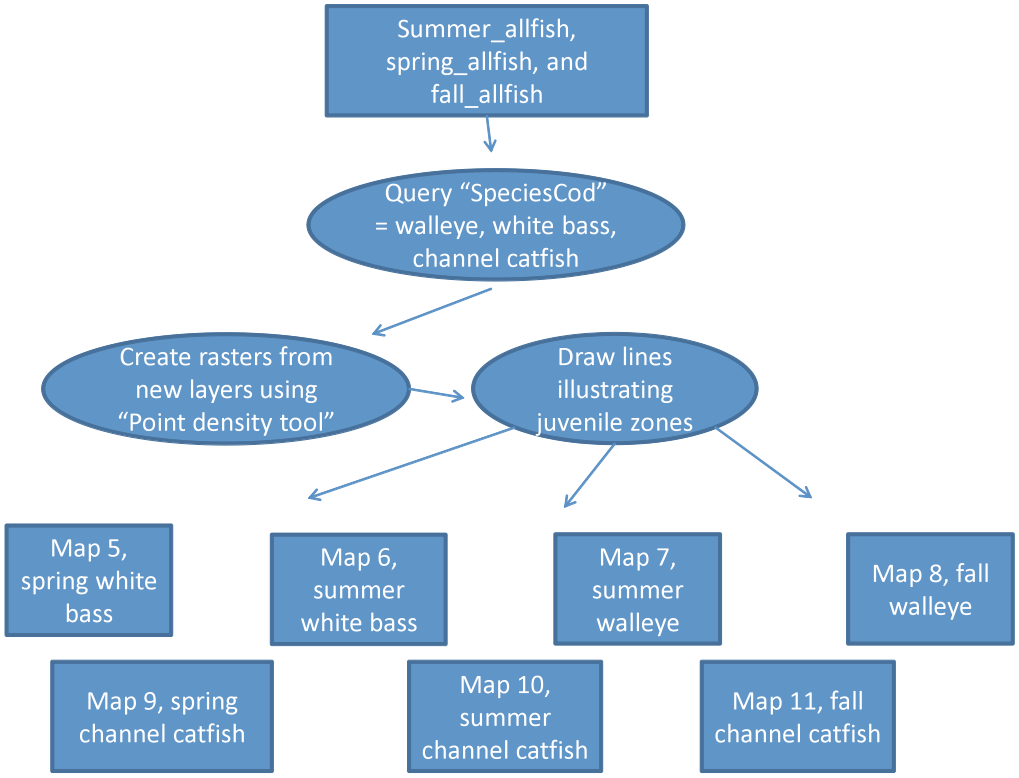
predator on larval and small juveniles were found in high densities inside the spring and summer zones indicating a high potential for negative interaction with June sucker **(Maps 5 and 6)** (Crowl et al 1998a). Walleye, which could potentially prey on juveniles in summer and fall, were found in moderate density within the summer zone **(Map 7)** but were largely absent in the general area in fall **(Map 8)** (Krueger and Hrabik 2005)**.** Channel catfish are not implicated as being as serious of a predator to young-of-year June sucker as white bass or walleye. Their high densities in the June sucker nursery grounds could actually be beneficial despite their potential to predate. Channel catfish have been identified as one of the most important predators of white bass and young-of-year carp in Utah Lake (Landom et al 2010). Their attraction to these areas overlapping June sucker reproduction could be coincidental and based upon the presence of large numbers of white bass and small carp **(Maps 9-11)**.

Data Quality, Accuracy, and Error

The foremost concern with the quality of the data used in this analysis is the logistical limitations to systematically sample the entire lake. Most sampling occurs nearshore where boat traffic is much lower and generally more fish are found. However, to more accurately spatially analyze the fish community of the lake, a more widespread, systematic approach to sampling should be employed. An additional concern is the process of collecting the data in the field on a hand-held GPS unit, recording to paper, then entering in a database; often by multiple employees. Digital field recorders could greatly reduce errors concerning this issue.

Flow Chart


allfish
Aerial_2006
Query "allfish" layer for "speciescod"
Point density tool on "suckers" layer
Map 1 "June sucker density in Utah Lake"
allfish
Aerial_2006
Query "allfish" layer for "sex", M or F
Query "allfish" layer for "length", <=400 and >=400
Query "allfish" layer for "skjn", and season
Map 2 "June sucker distribution by sex"
Map 3 "June sucker distribution by length"
Map 4 "Seasonal localities of June sucker"


Summer_allfish, spring_allfish, and fall_allfish
Query "SpeciesCod" = walleye, white bass, channel catfish
Create rasters from new layers using "Point density tool"
Draw lines illustrating juvenile zones
Map 5, spring white bass
Map 6, summer white bass
Map 7, summer walleye
Map 8, fall walleye
Map 9, spring channel catfish
Map 10, summer channel catfish
Map 11, fall channel catfish

References

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