


CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: Automated Analysis of Game Camera Images	
Sponsor Information: 	John Fennell Wildlife Specialist II Research Branch Arizona Game and Fish Department 506 N. Grant St., Suite L, Flagstaff, AZ 86004 jfennell@azgfd.gov

Project Overview:

The Arizona Game and Fish Department (AZGFD) is responsible for managing fish in the state of Arizona. One of the premier rainbow trout fisheries in the region is in the cold tailwaters below Glen Canyon Dam; this 15-mile reach is commonly referred to as the Lees Ferry fishery (Figure 1). To help better manage the fishery and understand its economic importance the AZGFD collects data on anglers (a person who fishes with rod and line) utilizing the fishery at Lees Ferry. These data are collected during creel surveys, which are a type of in-person survey where an interviewer (AZGFD employee) asks an



Fig. 1. Rainbow trout at Lees Ferry

angler questions about their fishing experience including questions related to how long they fished, how many fish they caught, and how they felt about their fishing experience. The AZGFD began a structured creel survey at Lees Ferry in 1977 and the angler interviews continue today providing a valuable long-term dataset to fisheries managers. Throughout the duration of the structured creel, interviews have typically occurred on six days out of the month. Creel surveys at Lees Ferry have been limited to an average of six days a month due to budget limitations. Stationing an employee at Lees Ferry for angler interviews is expensive and limits the number of days it is feasible to collect creel data. As such, the AZGFD has begun to explore options to collect additional data using remote camera technology to catalog overall angler use at the Lees Ferry fishery.

In 2015 the AZGFD installed a remote, automated camera (“game camera”) at the Lees Ferry boat ramp that collects an image of the boat ramp every 30 seconds throughout each day for the duration of the year. The boat ramp at Lees Ferry is the only access point for anglers using motorized boats to access the Colorado River to fish upstream reaches of the Lees Ferry fishery. Boat anglers make up a majority of anglers in the

Lees Ferry fishery and provide valuable data on how much use the fishery is receiving. By analyzing the daily image sets from the automated camera, we can better extrapolate our more limited in-person creel interview data to inform how many anglers use the fishery at Lees Ferry each year and how these patterns

change seasonally. This information will lead to a better understanding of the fishery and help the AZGFD better focus its management practices moving forward.

The Problem

While automated images are a way to supplement in-person angler interviews, they still require large amounts of time to process. The current method requires a person manually going through each image (up to 1,800 images/day) and counting boats and trailers that use the boat ramp. With images being collected every 30 seconds, the time required to manually sort through each photo is proving to be prohibitive. We are looking for ways to reduce time required to process images with the use of software designed for image analysis and classification.

Solution Overview and Details

Recent advances in image classification that utilize machine learning or similar approaches have made it possible to process large numbers of images in a much shorter amount of time. We are interested in having a software program that will automate processing of our camera images (Figure 2).

We are looking for the creation of a software program with these features:

- Group images by date and return boat and trailer counts for that day while not double counting boats/trailers that may appear in sequential photos.
- Accomplish these counts with images that may periodically slightly change the field of view being captured.
- Process images in low light conditions or with high sun interference (i.e. sunlight directly in camera).
- Contains a mechanism for evaluating or scoring how accurate boat counts are and provide a subset of images for human confirmation.
- Produce statistics of daily counts in table form.

Additional (stretch) goals for the program would be to:

- Identify and count kayaks and other small watercraft (paddleboards, canoes) that are taking out at Lees Ferry boat ramp.
- Recognize the same boat and trailer when it is launching a boat versus landing/trailering a boat to calculate how long individual boats were on the water.

This program will have to deal with multiple challenges related to the current images being collected including: images with different light exposure throughout the day, images from a faraway vantage point with relatively low resolution, and images with many subjects not of interest moving in and out of frame

between images. For this reason, our agency is flexible in the deliverables for this capstone project and are open to options that the team may think is more feasible given the available data. Additionally, we are currently in the process of installing a newer camera with greater resolution and will have those images available for analysis.

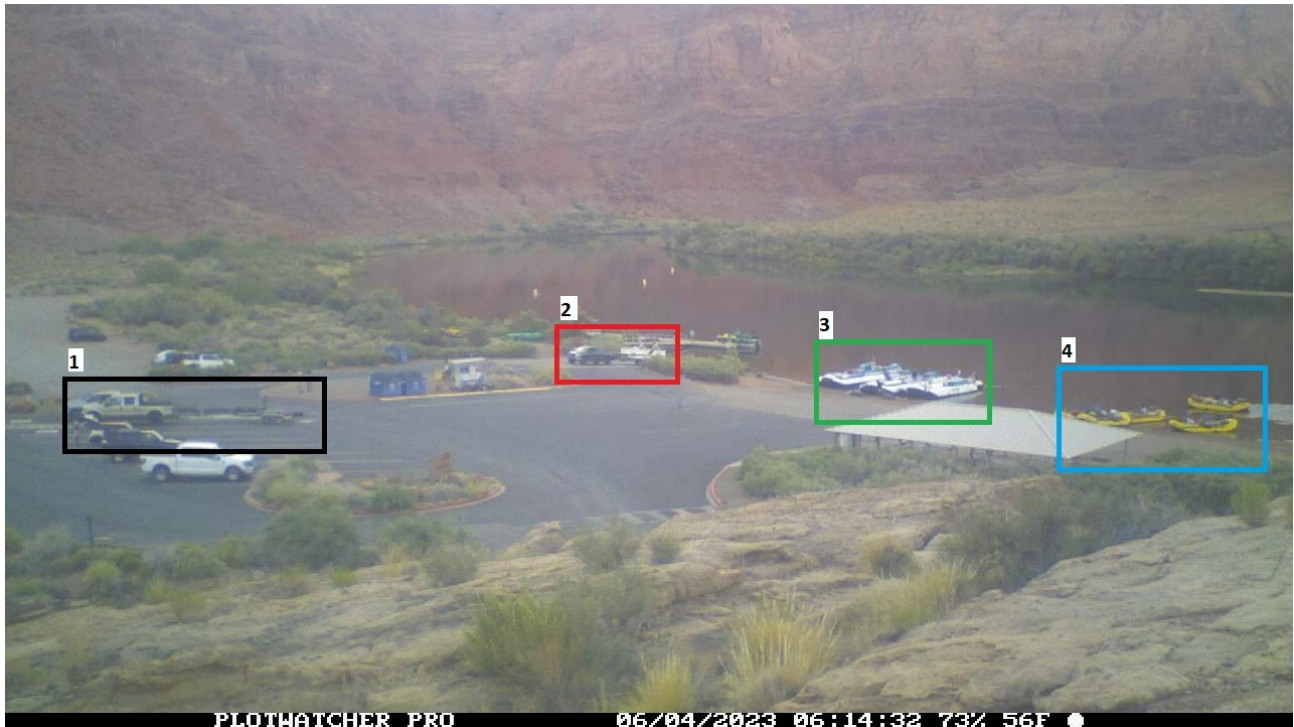


Figure 2: Example of boat ramp image to be analyzed. The image highlights some common items that may come up the software program may have to deal with. Item 1 (black square) is a car and boat trailer that has already launched and parked. Item 2 (red square) is a car and trailer that is in the process of launching a boat. Item 3 (green square) is a group of three commercial rafts that are not of interest to our analysis. Item 4 (blue square) is a group of private rafts that are not of interest to our analysis. Note this image is from an older camera with lower resolution. We will be installing a newer camera with greater resolution.

Impact of a successful solution

The development of a computer program will drastically cut down on processing time for image quantification and analyses. This would lead to a greater understanding of the use and importance of the Lees Ferry fishery to the state of Arizona. Additionally, this approach may also prove to be beneficial to other agencies who wish to quantify their angler use statistics at other popular fisheries across the country.

Knowledge, skills, and expertise required for this project:

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Equipment Requirements:

- Raw images that have not yet been processed will be provided. Additionally, images that have already been processed (boat and trailer counts have been recorded) can be provided as training data sets.

Software and other Deliverables:

- Our desired output is a computer program that can:
 1. Process half a million images per year and output only images that are of interest (i.e. images with fishing boats and trailers).
 2. Automatically count boat/trailers that are launching and landing and output the data to a database.
 3. Be able to flag images that will require human intervention.