Sampling the DNA of Hatchery Salmon – A Camera System for Identifying Sample Position

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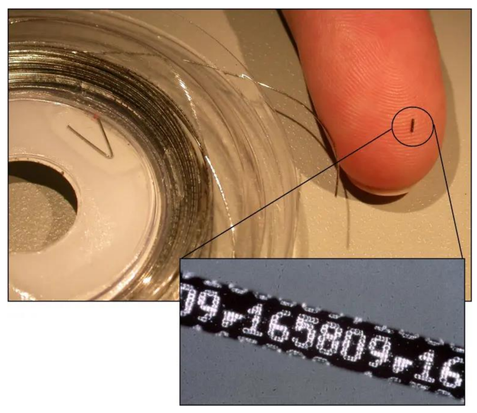
Background

Current methods of receiving data on hatchery salmon include the use of **Coded Wire Tags (CWTs)** to identify salmon from a given hatchery.

This data is used to advance our knowledge of the hatchery's success and its impacts on wild salmon populations.



CWTs are embedded into the heads of baby salmon before they are released from the hatchery. [1]

Salmon returning upriver to the hatchery are slid into special boxes like this one to detect if they have a CWT. Because of multiple sampling shortfalls, their reliability in scientific studies is questionable and may be subject to more bias than other methods.[2]

The Solution: DNA

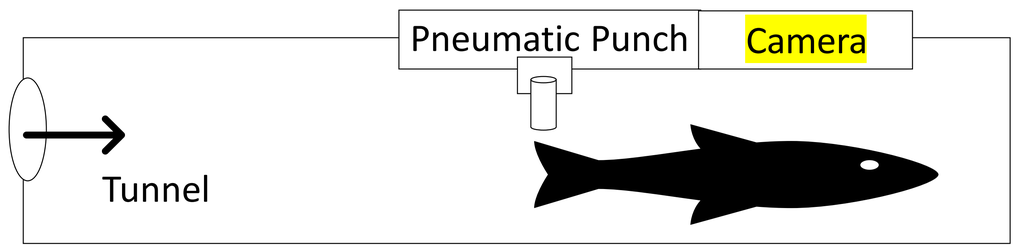
As opposed to the cost of implanting tags in millions of fish, DNA taken from substantially fewer parent fish will automatically identify all their offspring through genetic sequencing.

With genetic testing technology becoming increasingly cheaper, adding a DNA sampling mechanism alongside the CWT reader would allow for the collection of extra, more reliable genetic data.

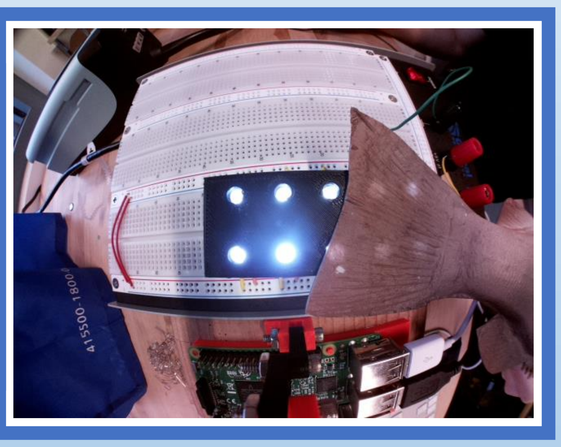
Methods

In order to take a sample (in this case, from the salmon's caudal fin), the sampling device first must know where the fish's tail sits within the sampling box.

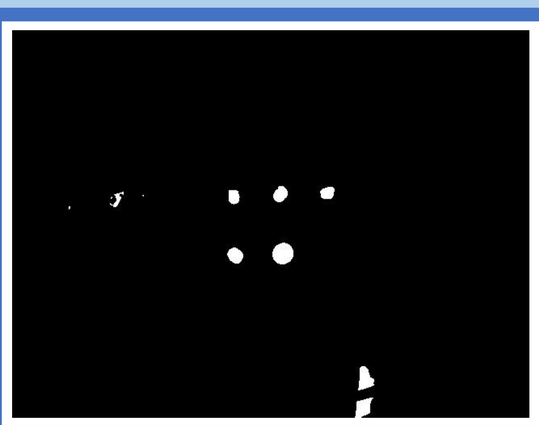
For fish of differing lengths, the approximate location of a salmon's caudal region can be found using a series of markers on the bottom of the sampling box, and a camera above them to image the scene.



A top-down image of the markers (and fish on top of them) is taken and saved to the Raspberry Pi

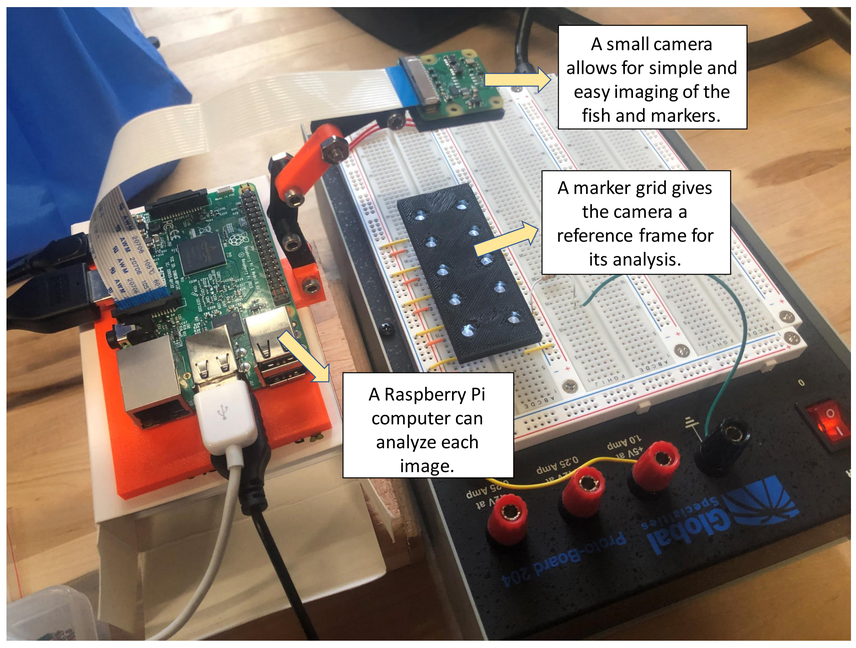


The image undergoes postprocessing, which removes fine detail and converts it to binary-color.



A Python program analyzes each image pixel and discovers which markers remain white and which become covered by the fish.

```
bwimg = Image.open('/home/imgFinal.jpg') # open image
# convert to black and white instead of default rbg
bwimg = bwimg.convert(mode='1',dither=Image.NONE)
pixels = np.array(bwimg,dtype=np.uint8) # convert image to array of pixels
pixels = np.nonzero(pixels) # nonzero values only - white pixels only

# separate x and y pixels
xpixels = pixels[1]
ypixels = pixels[0]

# list of x- and y-coordinates of markers
xcoords = [300,340,380,420,460,300,340,380,420,460]
ycoords = [220,220,220,220,220,260,260,260,260,260]

clearPoints = np.ones(len(xcoords)) # create array of ones to be modified later

# function for testing if marker is uncovered
for x in range(len(xcoords)): # loop through all markers
    for i in range(xpixels.size): # loop through all pixels
        # marker is clear if x AND y coordinates are contained within
        #  array of white pixels and are in the same column
        if (xcoords[x]==(xpixels[i]) and ycoords[x]==(ypixels[i])):
            clearPoints[x] = 0 # insert 0 into array if marker is not covered

coveredPoints = clearPoints.nonzero() # get the indexes of covered markers
```



A camera and Raspberry Pi on a 3D-printed mount point at a series of markers (LEDs), serving as a small-scale prototype.

When a fish slides over a marker, it is covered and thus ends up darker than expected in the image, alerting the computer to the fish's position. The computer can then deduce the approximate length of the fish and position of the fish's tail, all without any need for edge detection, image comparison, or any other fancy and complex software.

References

1. Northwest Marine Technology, Inc. (2020, December 7). *Coded Wire Tags*. Retrieved August 15, 2022, from https://www.nmt.us/cwt/

2. Pacific Salmon Commission. (2005, November). *Coded Wire Tag Program Review*. Retrieved August 15, 2022, from https://www.psc.org/publications/workshop-reports/coded-wire-tag-program-review/