What's That Fish?

Monitoring & identification of fish in the La Jolla Kelp Forest

Kian Bagheri & Helen Cai


San Diego Marine Protected Areas
SMCA
SMR
La Jolla
Site A
Site C
Site B
South La Jolla SMCA
South La Jolla SMR
2 mi
N

Motivations

- How do we know if MPAs are working?
- How can we better understand resident species?

  Active monitoring: trawling, diver surveys, costly efforts

  Passive monitoring: use noninvasive image and acoustic recording.

Objectives

Kian

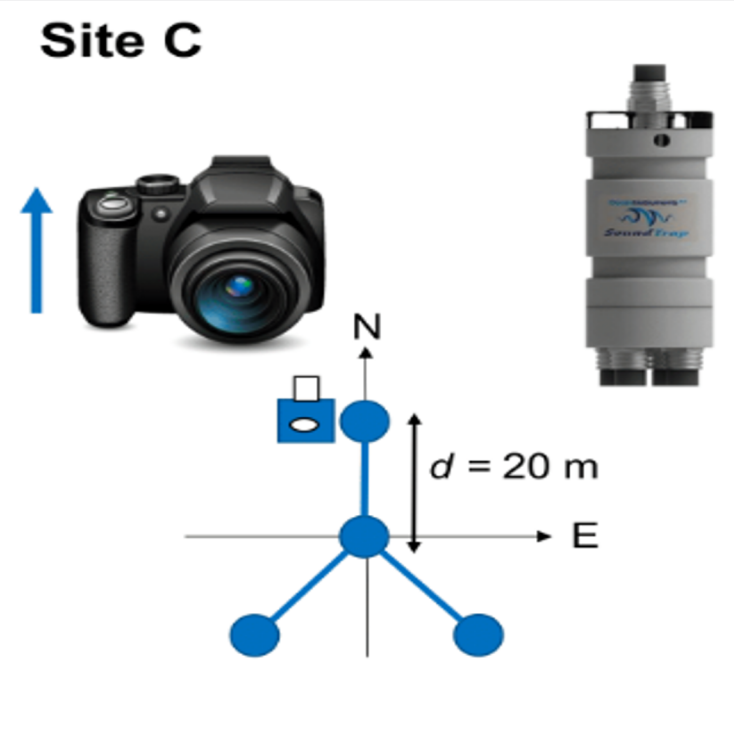
- Deploy/ Recover passive monitoring system
- Process and Analyze images

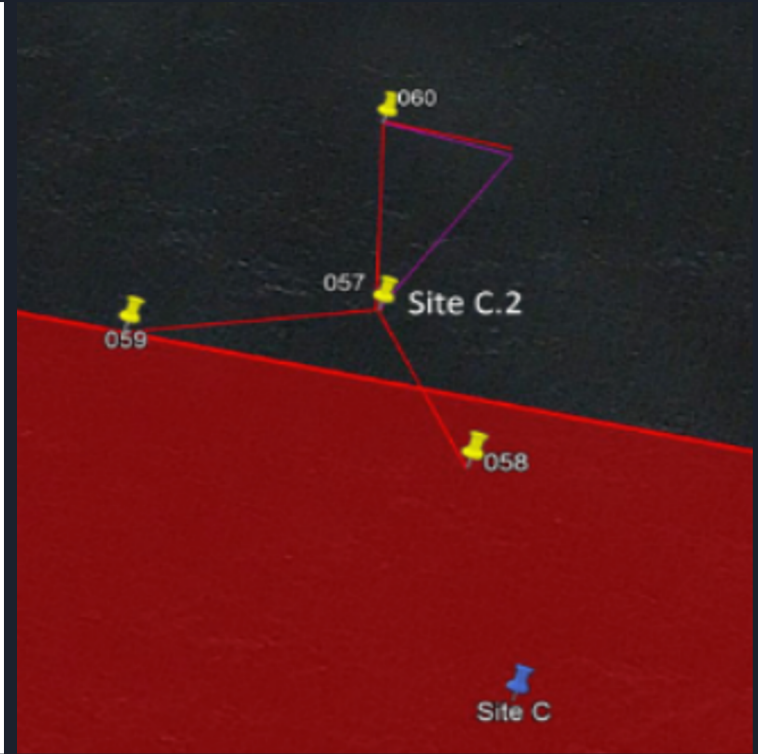
FishOASIS

- Fish Optical and Acoustic Sensor Identification System
- Verify identity of fish
- Correlate biologic acoustics with individual species

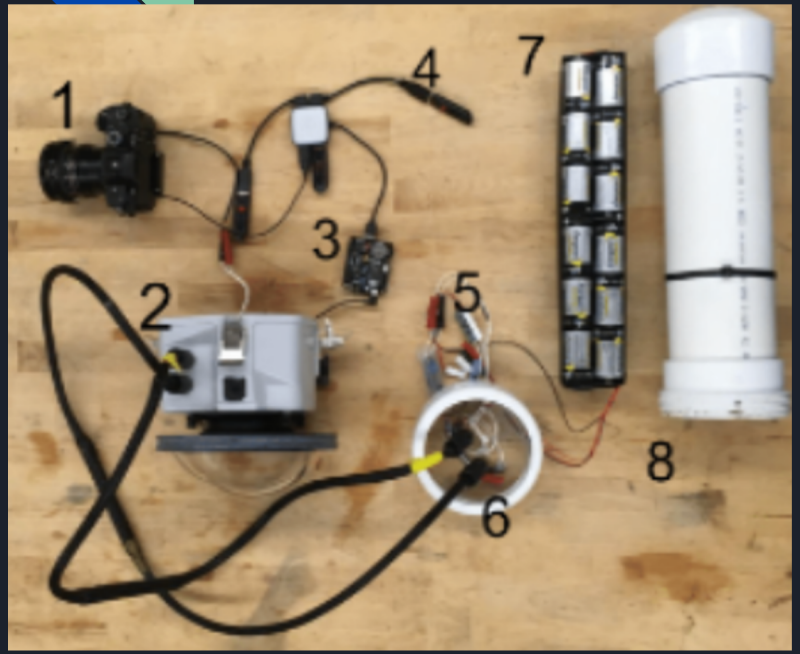

Site A
Site C.2
Site C
Site E
Site F
Site D
Site B

Array Setup





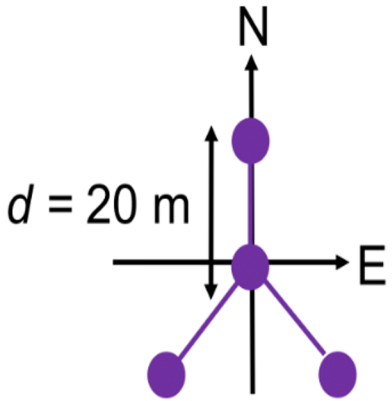
Camera: Hardware



Deployment

Hydrophone Array

Passive Acoustic System



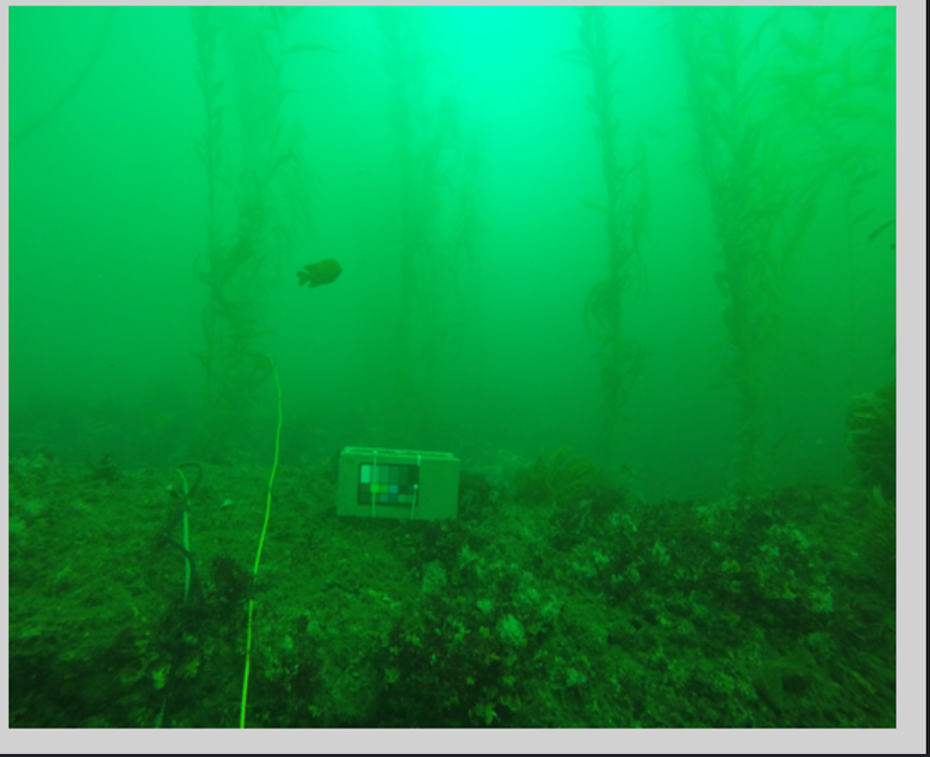
Components:

- SoundTrap ST4300 256 GB acoustic recorder
- four HTI-96-MIN hydrophones

Capabilities:

- sampling at 48-288 kHz
- up to 14 days continuous recording at 48 kHz

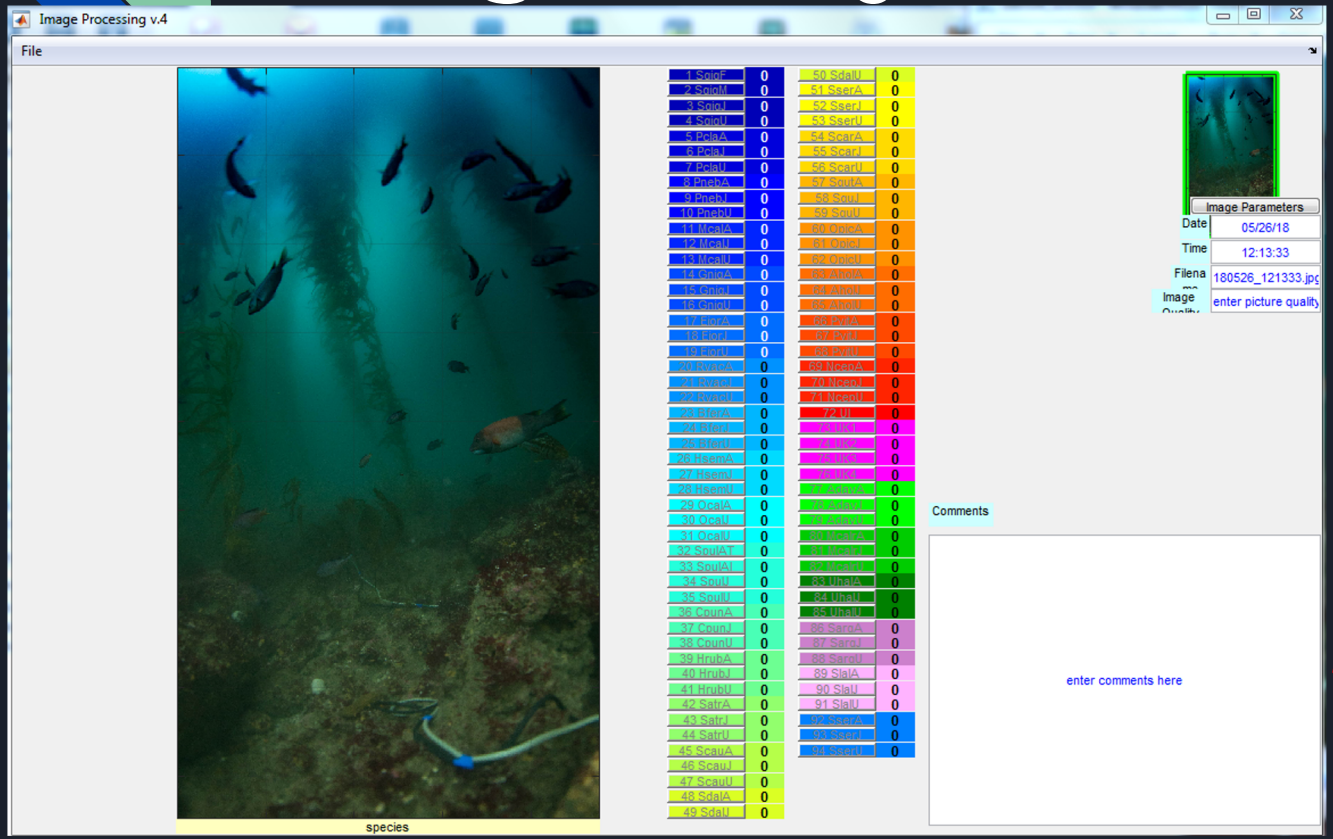
Image Processing: Raw Image

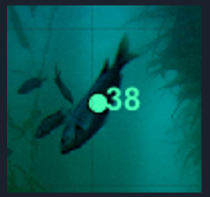


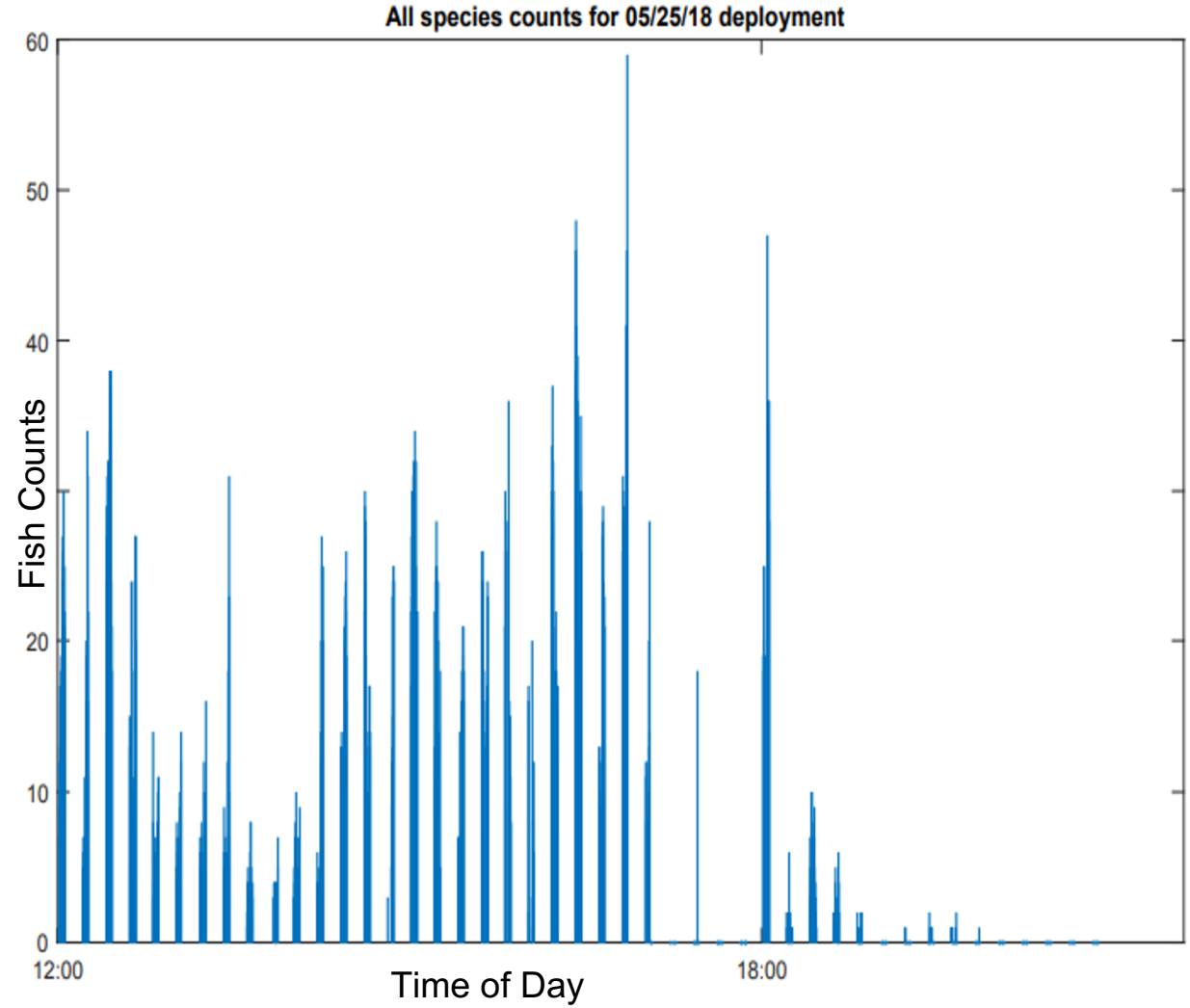
Sevengill Shark

"SOUTHERN" KELP BED ROCKY REEFS

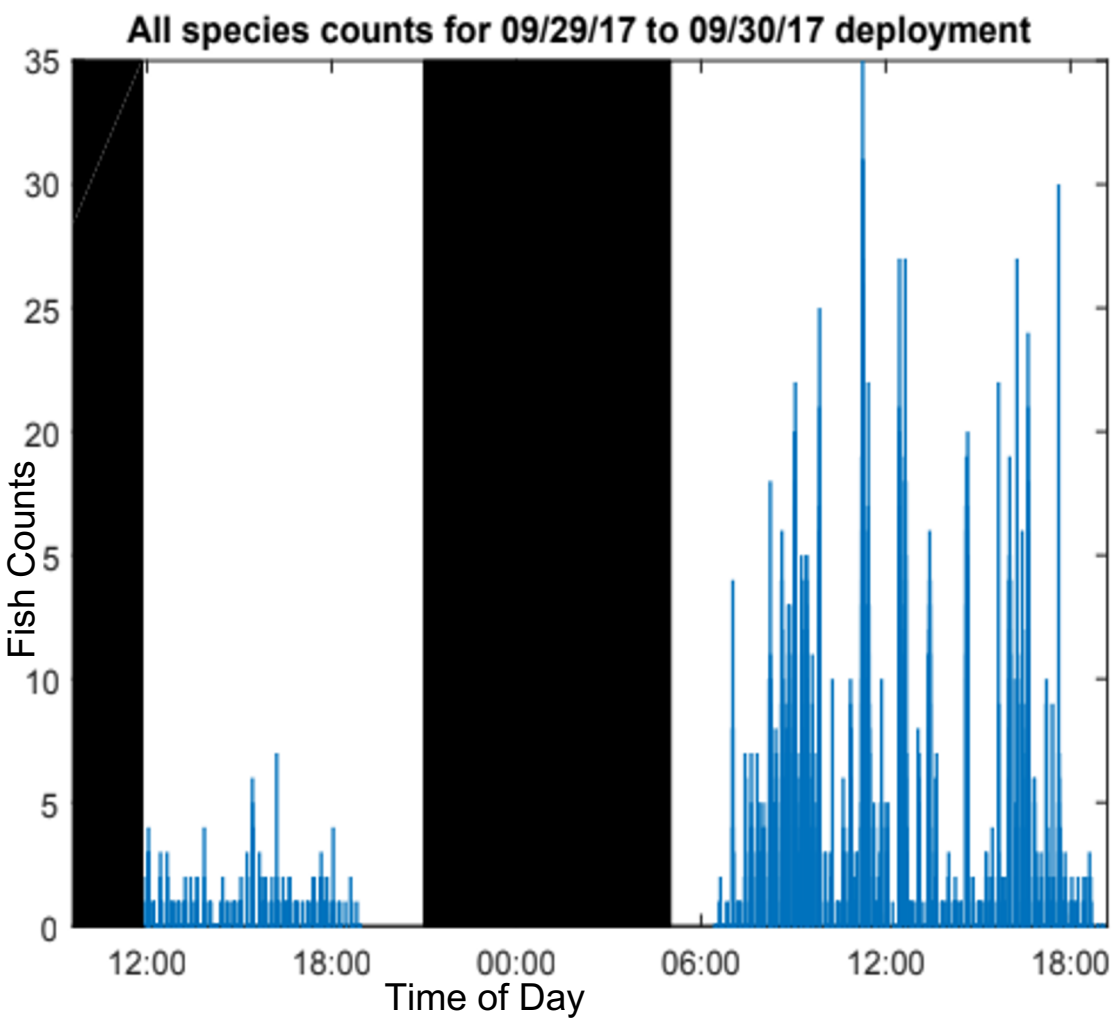
Image Analysis







Adult Kelp Bass	28
Adult Halfmoon	20
Adult Opaleye	2
Adult Black Surfperch	1
Pile Perch (unknown life stage)	1
Terminal Adult California Sheephead	11
Initial Adult California Sheephead	55
Juvenile California Sheephead	6
California Sheephead (unknown life stage)	7
Adult Blacksmith	313
Juvenile Blacksmith	297
Blacksmith (unknown life stage)	1437
Adult Garibaldi	75
Garibaldi (unknown life stage)	15
Adult Kelp Rockfish	4
Adult Painted Greenling	2
Unknown 1	6478



Adult Male Giant Sea Bass	2
Adult Kelp Bass	33
Kelp Bass (unknown life stage)	5
Adult Barred Sand Bass	1
Adult Halfmoon	80
Adult Opaleye	30
Opaleye (unknown life stage)	1
Adult Black Surfperch	30
Adult Kelp Perch	3
Adult Rock Wrasse	17
Juvenile Rock Wrasse	2
Rock Wrasse (unknown life stage)	1
Adult Senorita	76
Senorita (unknown life stage)	1
Terminal Adult California Sheephead	26
Initial Adult California Sheephead	74
California Sheephead (unknown life stage)	4
Adult Blacksmith	33
Juvenile Blacksmith	3
Blacksmith (unknown life stage)	4
Adult Garibaldi	149
Juvenile Garibaldi	47
Garibaldi (unknown life stage)	45
Adult Copper Rockfish	1
Adult Painted Greenling	5
Unknown 1	3656
Adult Anisotremus davidsonii	1

Outcomes

-Total # of Dives: 21

-Advancement of depth: Now eligible to dive between 60-100 feet

-Lead diver on three dives

-Greater knowledge of the species that reside within the kelp forest

-Giant sea bass spotting: 1!

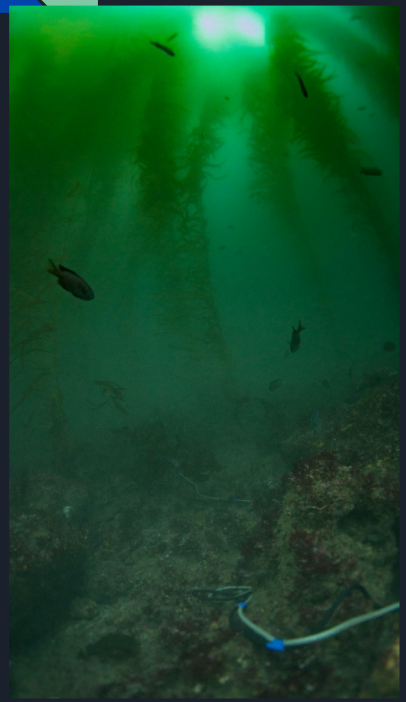
-Total # of Pictures analyzed: ~3600

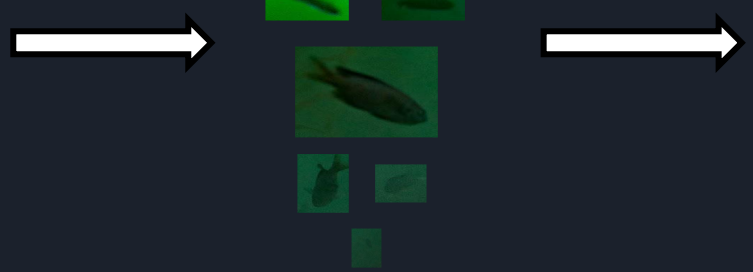
Objectives

Helen

- Analyze camera data
- Automate the process of identifying fish

Automated processing





```
Adult_Blacksmith
Unknown_1
Adult_Blacksmith
Adult_Blacksmith
Adult_Blacksmith
Adult_Blacksmith
Adult_Blacksmith
Unknown_1
```

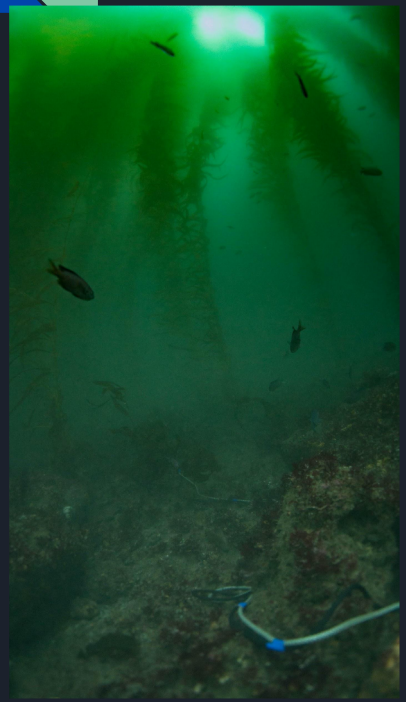
Raw image files

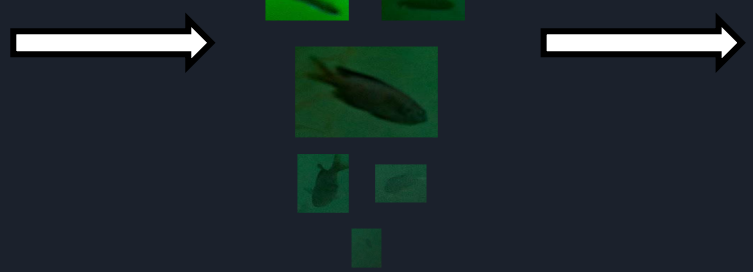
Object detection

Species classification

Automated processing

Automated processing





```
Adult_Blacksmith
Unknown_1
Adult_Blacksmith
Adult_Blacksmith
Adult_Blacksmith
Adult_Blacksmith
Adult_Blacksmith
Unknown_1
```

Raw image files

Object detection

Species classification

VIAME

Home CVPR 2018 Workshop Blog

An Open Source Framework for Underwater Image Processing

VIAME

Video and **I**mage **A**nalytics for a **M**arine **E**nvironment In cooperation with NOAA's Automated Image Analysis Strategic Initiative (AIASI), Kitware has developed VIAME, an open-source system for analysis of underwater video and imagery for fisheries stock assessment. VIAME will enable rapid, low-cost integration of new algorithmic modules, datasets and workflows.

View Project on GitHub

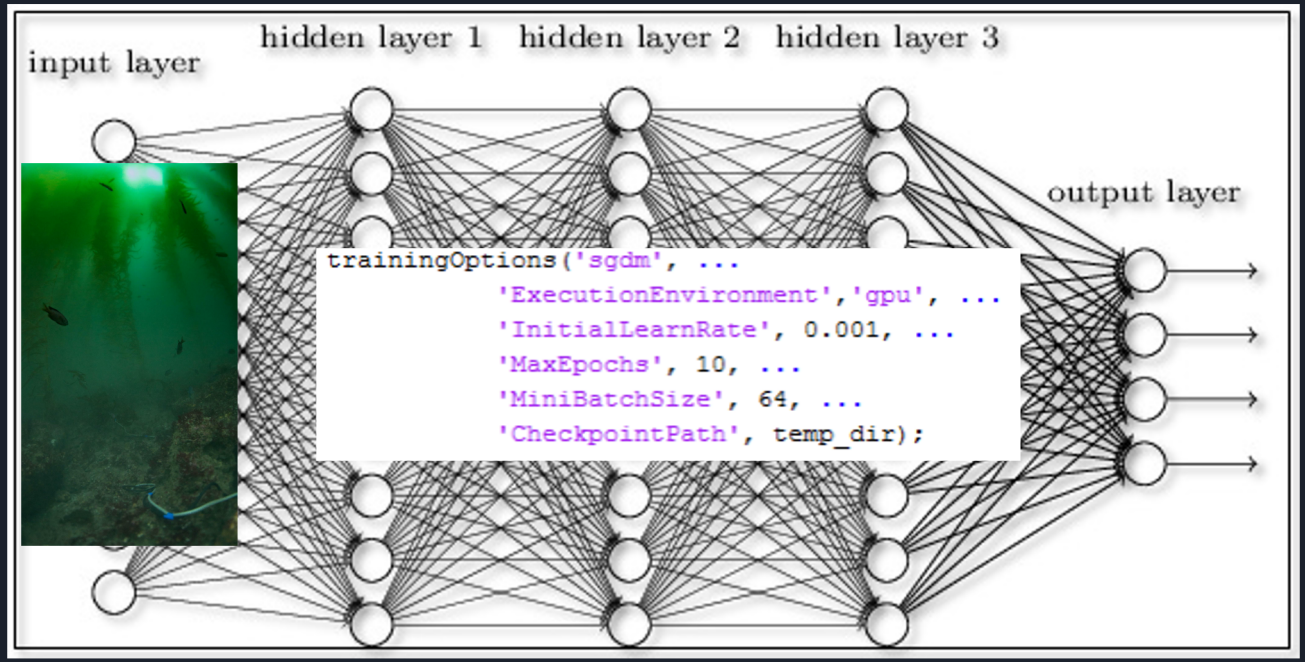
Why VIAME?

- **Modular Dataflow Architecture** enables straightforward integration of a wide variety of third party analytics, libraries and tools.
- **Open Source** basis fosters easy collaboration and transparent development for the widest possible community involvement.
- **Based on KWIVER**, the Kitware Video and Image Exploitation and Retrieval toolkit, which includes a pipelined image processing framework, baseline algorithms, and wrappers around algorithms from the broader computer vision community.

VIAME

- Weren’t able to build it on Windows or Linux
- Not guaranteed to work : not tested on our “type”
- Maybe in the future

Building from scratch



Convolutional neural networks (CNNs)

Building from scratch

1. Write the neural network
2. Train the neural networks on a known data set

   (Kian and Addison)
3. Optimize performance & accuracy
4. Use on real data

Writing the neural network

- MATLAB: Neural Network Toolbox makes things very convenient
- AlexNet is pretrained on 1000+ categories
- Transfer learning: modifying existing neural networks to output new categories

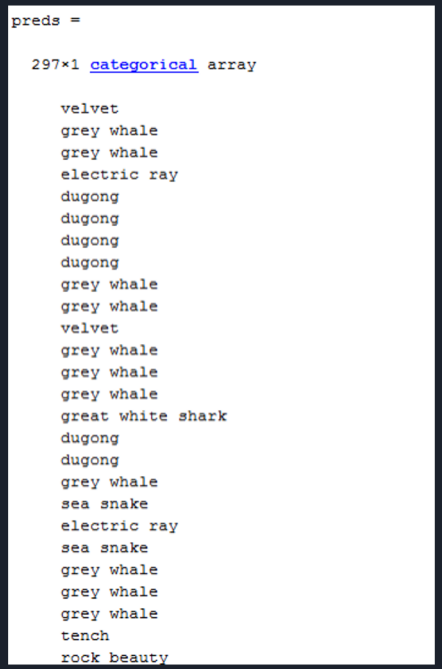
Writing the neural network

Need to write two neural networks:

boxnet, for object detection

fishnet, for species classification

Training object classification



AlexNet

fishnet

Training object classification (fishnet)

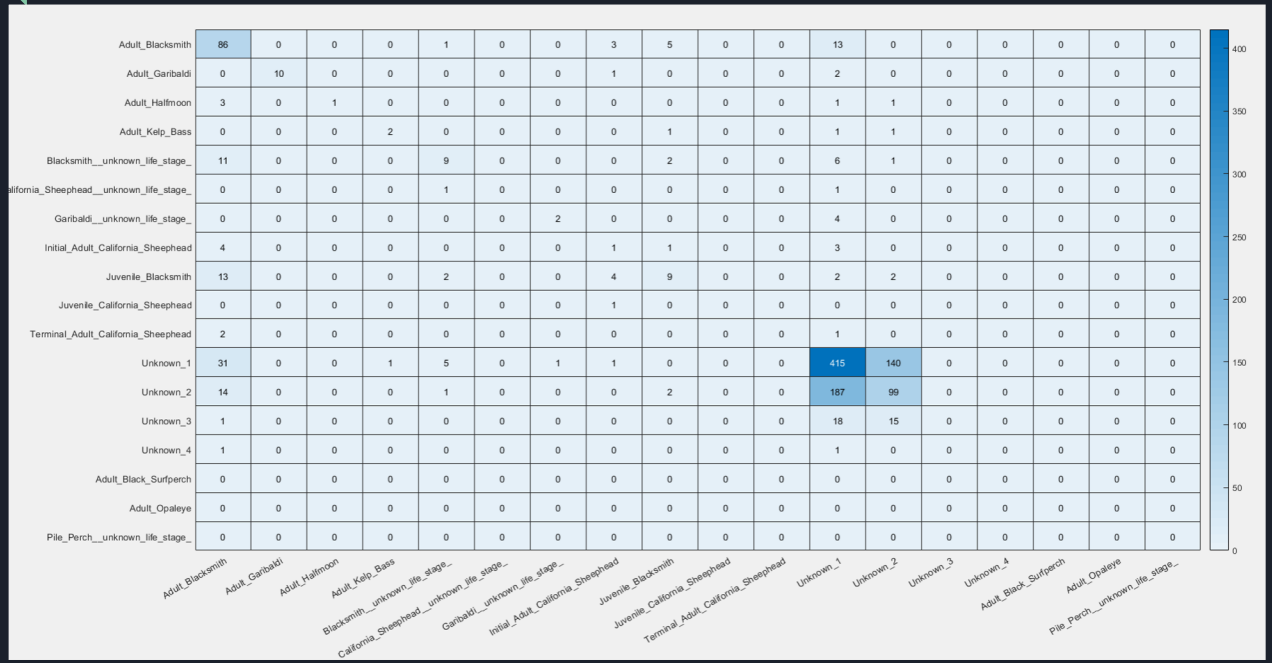
Split labeled images into different categories:

- training set
- validation (test) set

Training object classification (fishnet)

- Zoom in/out to standard size
- Make different labels based on different groups
- More is more

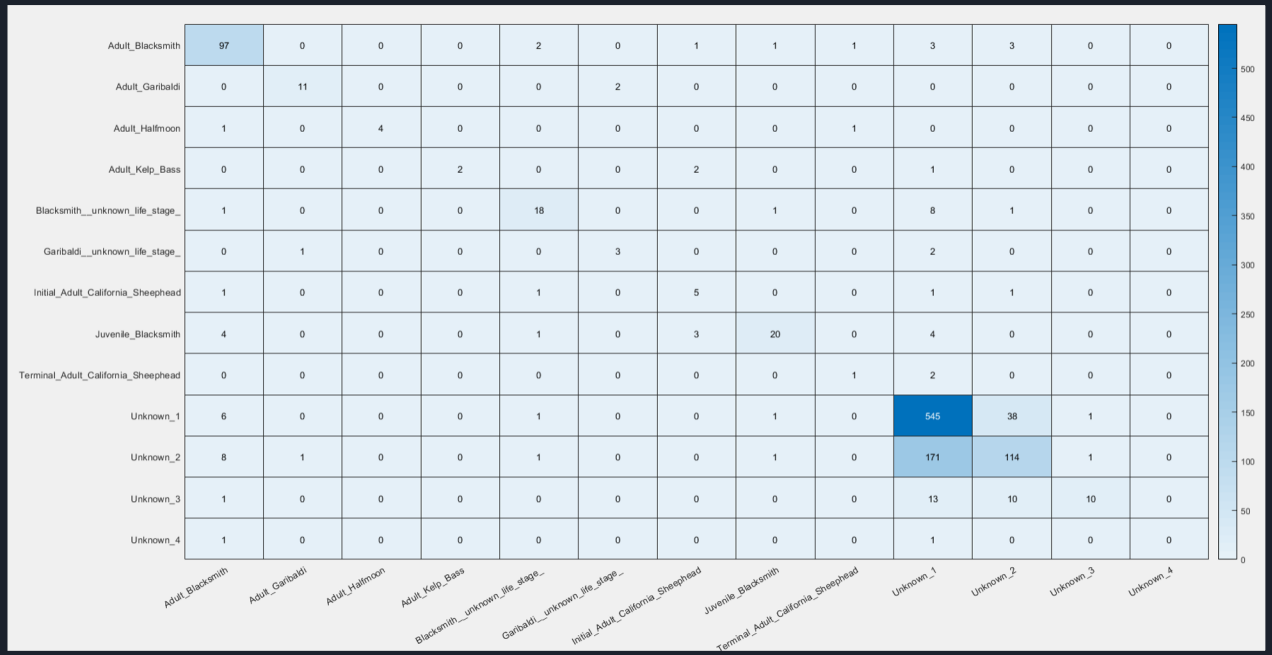
Optimizing performance



F1 = 0.3292

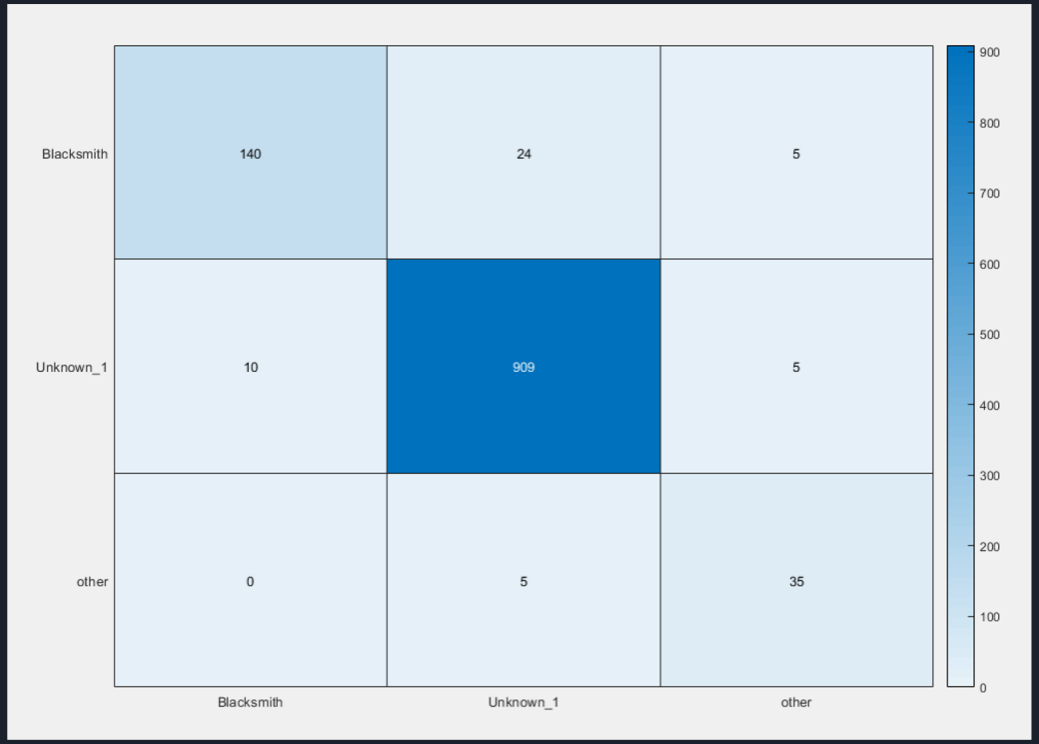
Confusion matrix

Optimizing performance



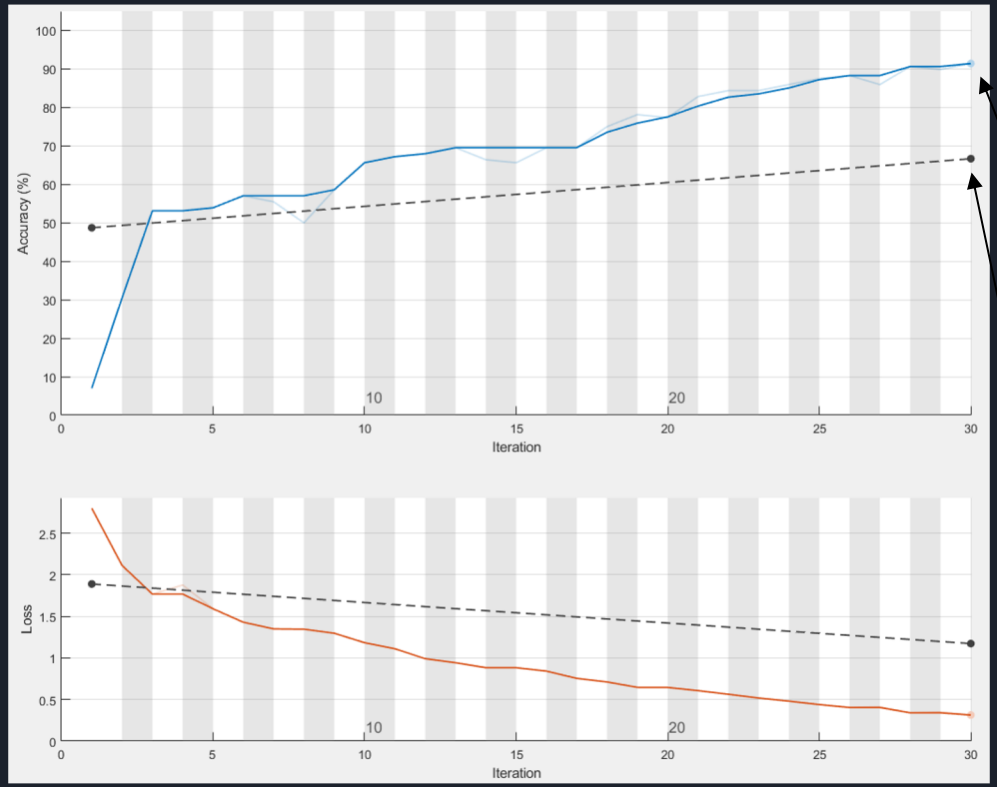
F1 = 0.6039

Optimizing performance



F1 = 0.8946

Optimizing performance



Training accuracy = 92%

Validation accuracy = 67%

Optimizing performance

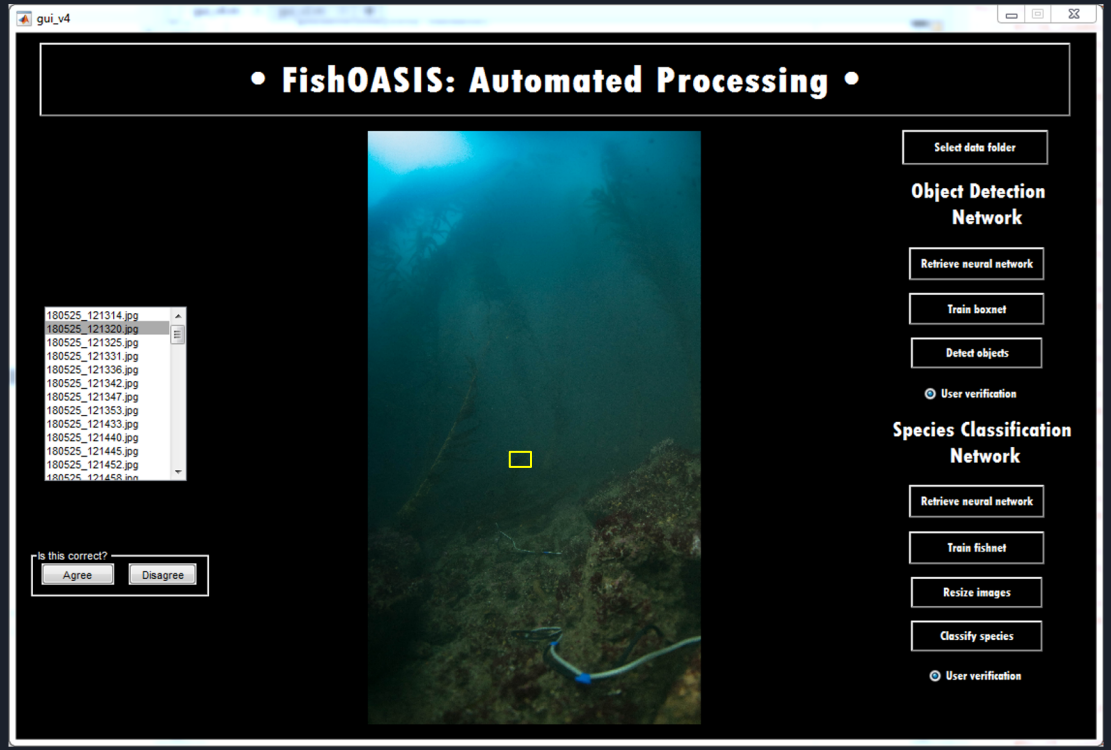
- Increasing size of training set
- Data augmentation
- Adjusting layers of the neural network *(in progress)*

Training object detection (boxnet)

- Faster R-CNNs require a lot of memory and processing ability
- Our images are 2384 x 4240 pixels
- Strategically downsize & resample
- Use new computing resources:

  Google Cloud machine with GPU

Use on real-world data



Use on real-world data

Use on real-world data

- Automated detection is at an impasse
- Object detection is still done by hand
- Species classification performs relatively well on novel data

Conclusion

- Lots of image analysis
- Lots of deployment and data collection

Big picture

- Identify and count fish in pictures
- Correlate image IDs with acoustic data
- Figure out what is in the MPA

Acknowledgements

- Camille Pagniello
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