Abstract — In recent years, ecologists and biologists have increasingly relied on remote video and image based methods to examine and monitor marine habitats, particularly those beyond easy diving depth.

Transforming raw visual data into quantitative information useful for science presently requires substantial effort by human experts [1]. Such barriers are hampering the data free-flow needed to assist policy makers to design and implement ocean management planning [2].

Consequently eResearch tools that provide consistent methods to analyse, annotate and integrate marine data collected from multiple sources and methods are being developed.

Index Terms — Automatic classification, marine, imagery, videography, data aggregation, annotation.

I. INTRODUCTION
Transforming raw visual data into quantitative information useful for science and policy decisions requires substantial and ever-increasing human intervention. However the lack of standardisation regarding cataloguing, annotation, classification and analysis of this imagery from the various ‘silos’ of data existing in multiple organisations across Australia is problematic. Specifically diverse underwater imagery / video systems and disparate data collection methods create a complex situation.

By partnering with the marine ecology community Collaborative and Annotation Tools for Analysis of Marine Imagery and video (CATAMI) are being be developed, providing easy-to-use workflows to allow marine researchers to effectively use quantitative information for the management of Australia’s marine environment.

II. METHODOLOGY

In the CATAMI Project Agile methodology is being used in a Linux environment to create:

- An online access and browsing tool for data collected by Autonomous Underwater Vehicles (AUV), Baited Remote Underwater Video Stations (BRUVS), Remote Operated Vehicles (ROV) and Towed Video (TV) collections
- Analysis and annotation tools to ensure data is collected and consolidated consistently
- An automated image classification tool

For sustainability, the tools developed will integrate with the existing and anticipated future architectural structures of the Australian Ocean Data Network (AODN). The way in which these eResearch tools will work together is presented in Fig 1.

A technical working group, with well-structured opportunities for participation is guiding the process to mitigate the development of unsatisfactory and inaccessible infrastructure. Some of the challenges encountered by the technical working group to date include:

**Large Data**
The quantity of raw marine data and imagery highlight the impracticality to having this data available on-demand. The methodology used will ensure tools developed are able to interface easily with archival data storage systems, wherever possible.

**Automatic Image Analysis**
The development of tools for the automatic classification of underwater imagery is complex, especially if classification is being carried out in real-time [3]. Underwater imagery and videography is constantly challenged by light absorption, magnification, water particulates (e.g. plankton bloom) causing light scatter, light shadowing, water motion from natural features e.g. weather, currents and human intervention, e.g. boat traffic [3].
To tackle this challenge, both two-dimensional (2-D) and three-dimensional (3-D) imaging systems [4] developed elsewhere will be built upon. As there is a growing trend towards 3-D single object recognition, to extract features from multiple image views, this approach will also be used. Images and patterns validated by marine experts will provide a base line reference point. In any research study with human observes, bias, or variation (due to interpretation) between subject experts is expected; this will limit the reliability of the data [5]. Consequently any bias in the recognition of marine species or architecture from an automated image classifier should not exceed the statistical variation observed when marine experts perform the same analysis [6].

Over time this approach to automatic image classification may also incorporate data fusion techniques to consider various factors including light variations, sea turbidity and temperature etc. (subject to data available) [7]. By combining independent data together in a spatial grid, a single robust view may be created for the subsequent tool development.

III. RESULTS

Although this project is at an early stage, a standard hierarchical classification structure for underwater image collections has been developed with researchers from across Australia; this structure will be used to facilitate data cataloging and subsequent aggregation. This formal by flexible classification will be deployed in the uploading and labelling interface of the CATAMI tool to enable researchers to capture as much detail as desired for project specific purposes. Simultaneously this structure will support a common ‘higher’ level classification for comparison across Australia.

IV. CONCLUSION

Project CATAMI will ensure that researchers are able to access data to identify particular species and/or taxonomic levels and associate these data with environmental conditions including the nature of the substrate or temperature, salinity, current and depth profiles. Project CATAMI tools will also support standardized and accurate quantitative estimates of benthic cover and marine species distributions from data collected. Once complete, Project CATAMI will make these eResearch tools available online through a Research Cloud and the AODN, to enable marine scientists to focus on specific marine research questions to transform marine ecology investigations.

ACKNOWLEDGMENT

This project includes development funded by the National eResearch Collaboration Tools and Resources (NeCTAR) and the University of Western Australia. NeCTAR is an Australian Commonwealth Government (Department of Industry, Innovation, Science, Research and Tertiary Education) project conducted as part of the Super Science initiative and financed by the Education Investment Fund. http://nectar.org.au

This is a nationally funded collaborative project. Present Partners include: Curtin University University of Sydney – (Australian Centre for Field Robotics), IMOS, Australian Institute of Marine Science (AIMS), CSIRO Marine and Atmospheric Research (CMAR), National Environmental Research Program (NERP), the Australian National Data Service (ANDS), University of Tasmania, University of Western Australia, Sydney Institute for Marine Science, Department of Primary Industries – NSW, Institute for Marine & Antarctic Science (IMAS), WA Department of Environment and Conservation and Geoscience Australia.

REFERENCES