Baited Remote Underwater Video Systems (BRUVS) - Assessment Guidance

Assessment background |

Baited Remote Underwater Video Systems (BRUVS) are a non-invasive technique for conducting marine biology research. Several different BRUVS (e.g. mono and stereo) and types (e.g. benthic and pelagic) have been developed all of which use bait to attract individuals of mobile species in the vicinity into the field of view of a camera. Here you will use an existing dataset gathered from surveys of 3 habitats in the Isles of Scilly, UK to describe differences in species richness (number of different species) and relative abundance (number of individuals) among surveyed habitats. This data was gathered to create baseline data on the marine environment to promote sustainable resource use, as well as support monitoring of the existing marine protected area network.

Study location and deployment summary |

Baited Remote Underwater Video Systems (BRUVS) were deployed in the waters around the Isles of Scilly (IoS) (**Figure 1**) across three habitat types: rocky reef and kelp forests, sediments (sandy bottom) and seagrass beds. The following section provides an overview of data collection and deployment parameters.

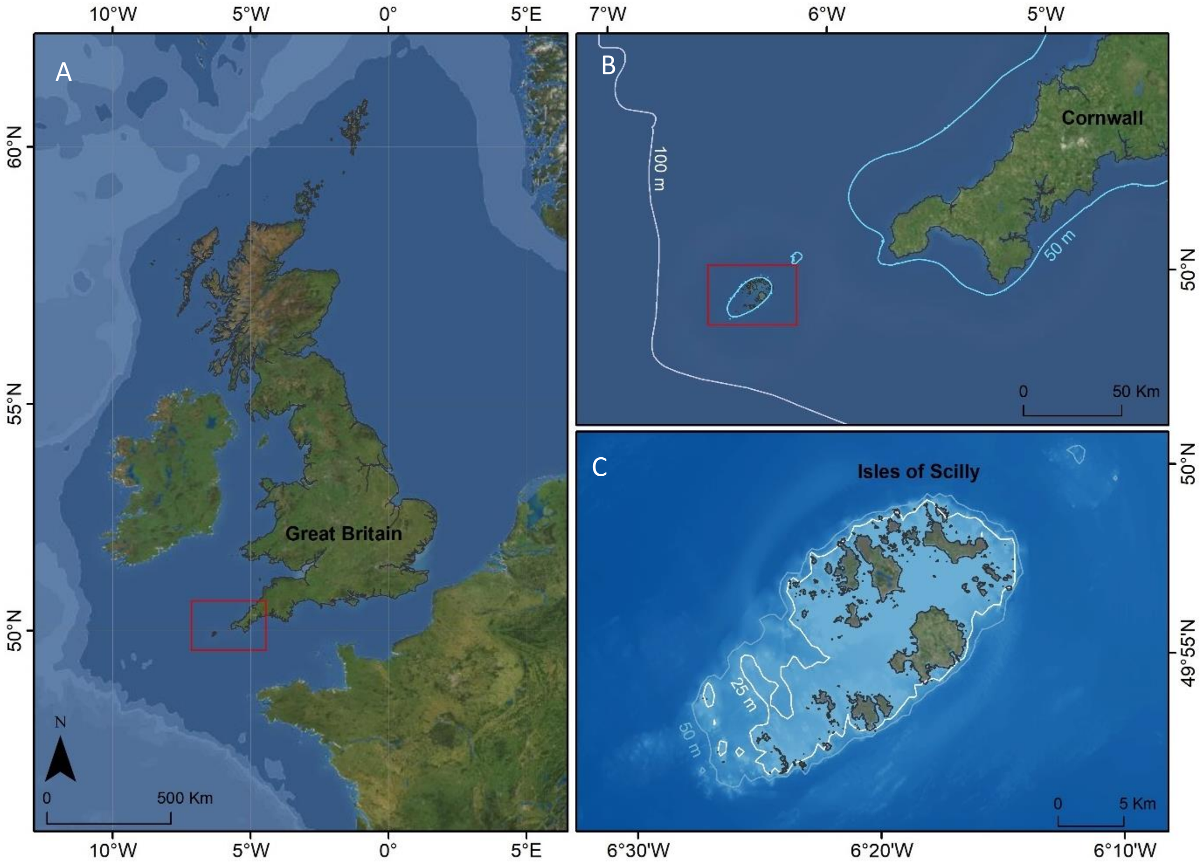


Figure 1 | Study location (A) North-western Europe with inset of South west United Kingdom, (B) Isles of Scilly inset in relation to the Southwest UK coast and (C) Isles of Scilly archipelago with 25 and 50 meter depth contours highlighted.

METHODS (simplified)

Construction:

- BRUVS were constructed from PVC tubing (36 mm in diameter) arranged to form a prism shape to create a 79 cm X 62 cm base for stability and weighed down with four 1 kg weights attached to each corner (**Figure 2**).

- Each BRUV had a single front facing (GoPro) camera located 35 cm above the sea floor.
- Each bait cage was mounted in front of the camera at a distance of 120 cm from the camera.
- Each BRUV device was tethered to a buoy at the surface.

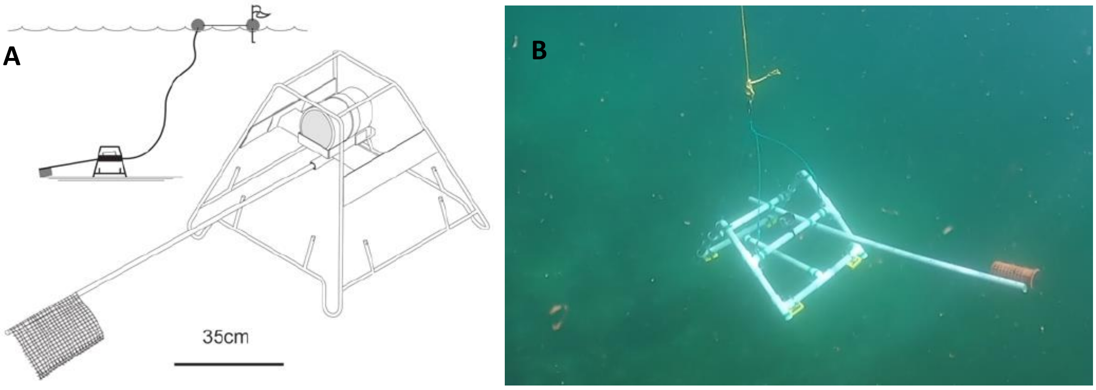


Figure 2 | BRUVS deployment: (A) schematic indicative of the prism-shaped frame with rope and bouys; and (B) pictures of the actual rig underwater.

Deployments:

- BRUVS were deployed between May and September 2023.
- 10 deployments (30 in total) were randomly sampled from a wider survey regime in each of three habitats (**Figure 3**), spaced at a minimum of 200 meters apart to account for bait plume influence.
- 250 g Atlantic mackerel (*Scomber scombrus*) was used as bait for each deployment.
- Bait was defrosted and crushed prior to deployment (to maximise freshness).
- Each BRUV was deployed for at least 60 minutes during daylight hours (8.00 and 19.00) and in a 2-hour window either side of high tide slack water to minimise the effects of tidal flow on deployments.
- All deployments were in water <40m in depth (due to lower visibility beyond this point).

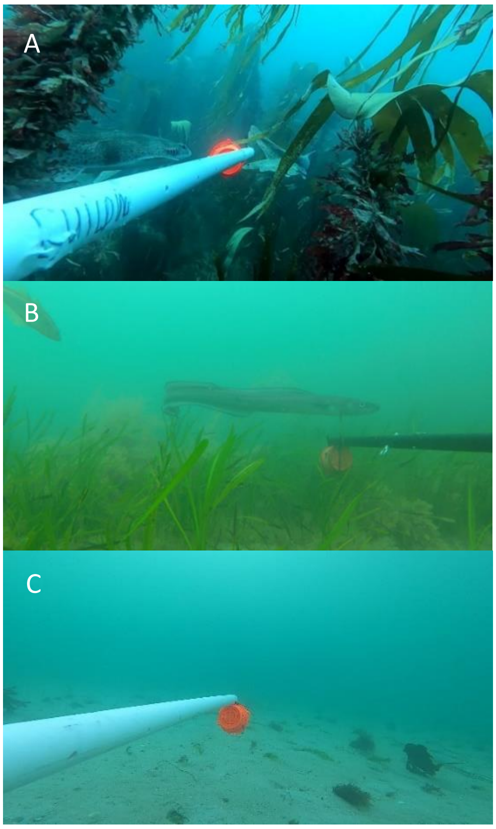


Figure 3 | Three broad-scale habitat classifications: (A) rocky reef and kelp with lesser spotted catsharks (*Scyliorhinus canicula*); (B) seagrass beds (*Zostera marina*) with conger eel (*Conger conger*) and (C) bare sandy seabed.

Video & data analysis |

Of the 30 deployments, footage from 27 have been watched and the data transcribed by 2 observers into a database (provided). Videos were analysed for a period of 60 minutes from when the BRUV hit the seafloor. For this assessment you will each need to watch the remaining 3 videos (1 for each habitat type) and record each species and the maximum number of individuals of each species observable at one time (hereafter referred to as MaxN). Once you have analysed the footage, your data needs to be compiled, and two commonly used metrics generated – species richness (the number of different species represented in an ecological community, habitat, landscape or region) and relative abundance - defined as MaxN of specific species or taxa per hour (i.e. per 60 minute video). To help with the calculation of relative abundance (MaxN) we have appended additional information to each species – including order and families (derived from the World Register of Marine Species, WoRMS; marinespecies.org) and functional groups (derived from the Sea Around Us project; seaaroundus.org).

Analysing video data: to help with species identification we have provided a species list and an identification guide. We have also provided a tutorial to illustrate how to record information from BRUV videos into a database, as well as an example of how to calculate species richness and relative abundance (MaxN). These resources are available on ELE – it is important that you refer to these before starting your assessment.

When analysing the data for your assignment **please answer the following question**:

Q. What are the observed differences in species richness and relative abundance among habitat types?

And then answer one of the three following questions (tip – explore the data prior to making a decision):

Q1. What are the observed differences in species richness and relative abundance for predatory species (catsharks, nursehounds, tope and conger eels) among habitat types?

Q2. What are the observed differences in species richness and relative abundance for commercially exploited crustacean species (common spiny lobster, edible crab, spiny spider crab and European lobster) among habitat types?

Q3. What are the observed differences in species richness and relative abundance for Labridae (i.e. wrasses) among habitat types?

Q4. What are the observed differences in species richness and relative abundance for commercially exploited fin fish species ('Cod likes') amongst habitat types?

How does the second question compare with the total observed species richness and abundance results?

Assessment format |

For this assessment you will produce a 2,000 word scientific report outlining the findings of your analyses. This must be structured like a scientific paper and include the following sections:

- Title (not included in the word count)
- Abstract (200 words maximum)
- Introduction (400 Words)
- Methods (400 words) comprising:
  - Study area
  - Data collection

The word counts for these sections (i.e. introduction through to the end of the discussion) are indicative and provided as a guide to help you structure your write up.

- Video and data analysis

- Results (400 words):
- Discussion (600 words)
- References (25 maximum – and are excluded from the word count)

Writing up your assessment: Please see responses to **FAQs on pages 6 - 8** if you require further clarification or support when writing your assessment.

A few things to note. This dataset is a small subset of a much larger survey. Clear, obvious ecological patterns are often hard to elicit with small sample sizes, hence why we try to build large datasets. However, for this assignment your discussion should focus on how the information derived (i.e. your findings) can be useful for the benefit of conservation and management (refer back to background) as if they were a complete study. Avoid dwelling on what is wrong with the study. How often do you see a scientific paper undermining their own study? They don't. They do, however, allude to potential limitations and caveats. When writing you discussion other considerations you may want to discuss include the following pointers:

- How are these data and your findings likely to be useful for guiding policy and management decisions (i.e. fisheries regulations, marine protected area design)?
- How could future BRUVS studies in the Scillies be improved (i.e. consider bait type, deployment duration, sampling effort and strategy, and BRUVS types)?
- How could you address potential errors or concerns with using 3 different observers to watch videos and record data?
- What other metrics could be gleaned from video (BRUVS) data (think displays of behaviour, timings etc.)?
- Looking at the three analysed videos, what issues may occur by including small and cryptic benthic species (i.e. dog whelks) in your abundance and species richness results?
- What other variables/considerations could be included in your analysis to help explain observed differences?

Finally, this assignment is about you learning to analyse BRUVS data, visualise your findings and present them in the context of the BRUVS and marine protected area literature. It isn't a stats test (although simple stats will be useful to determine variation between habitat types). It is also not a British species ID test. Do your best to make accurate IDs, but also don't panic if you can't determine a what every fish you see is.

Suggested reading |

There is a wealth of scientific literature on: (1) calibrating BRUVS for deployment (i.e. optimal soak times); (2) effects of bait type on species responses (i.e. detection); (3) deploying BRUVS to address a range of questions from characterising species communities and biomass in different habitats, to comparing species responses to different types of management and assessing the effectiveness of marine protected areas; and finally (4) recent advances in marine video image analysis (i.e. deep learning for automated analysis and species identification). The following papers are just a few key publications on these topics.

1. Whitmarsh, S.K., Fairweather, P.G., Huveneers, C., 2017. What is Big BRUVver up to? Methods and uses of baited underwater video. Rev. Fish Biol. Fish. 27, 53–73. https://doi.org/10.1007/s11160-016-9450-1
2. Unsworth, R.K.F., Peters, J.R., McCloskey, R.M., Hinder, S.L., 2014. Optimising stereo baited underwater video for sampling fish and invertebrates in temperate coastal habitats. Estuar. Coast. Shelf Sci., Special issue on Problems of Small Estuaries 150, 281–287. https://doi.org/10.1016/j.ecss.2014.03.020

3. Birt, M.J., Cure, K., Wilson, S., Newman, S.J., Harvey, E.S., Meekan, M., Speed, C., Heyward, A., Goetze, J., Gilmour, J., 2021. Isolated reefs support stable fish communities with high abundances of regionally fished species. Ecol. Evol. 11, 4701–4718. https://doi.org/10.1002/ece3.7370

4. White, J., Simpfendorfer, C.A., Tobin, A.J., Heupel, M.R., 2013. Application of baited remote underwater video surveys to quantify spatial distribution of elasmobranchs at an ecosystem scale. J. Exp. Mar. Biol. Ecol. 448, 281–288. https://doi.org/10.1016/j.jembe.2013.08.004
5. Espinoza, M., Araya-Arce, T., Chaves-Zamora, I., Chinchilla, I., Cambra, M., 2020. Monitoring elasmobranch assemblages in a data-poor country from the Eastern Tropical Pacific using baited remote underwater video stations. Sci. Rep. 10, 17175. https://doi.org/10.1038/s41598-020-74282-8
6. Goetze, J.S., Wilson, S., Radford, B., Fisher, R., Langlois, T.J., Monk, J., Knott, N.A., Malcolm, H., Currey-Randall, L.M., Ierodiaconou, D., Harasti, D., Barrett, N., Babcock, R.C., Bosch, N.E., Brock, D., Claudet, J., Clough, J., Fairclough, D.V., Heupel, M.R., Holmes, T.H., Huveneers, C., Jordan, A.R., McLean, D., Meekan, M., Miller, D., Newman, S.J., Rees, M.J., Roberts, K.E., Saunders, B.J., Speed, C.W., Travers, M.J., Treml, E., Whitmarsh, S.K., Wakefield, C.B., Harvey, E.S., 2021. Increased connectivity and depth improve the effectiveness of marine reserves. Glob. Change Biol. 27, 3432–3447. https://doi.org/10.1111/gcb.15635
7. Wraith, J., Lynch, T., Minchinton, T.E., Broad, A. and Davis, A.R., (2013). Bait type affects fish assemblages and feeding guilds observed at baited remote underwater video stations. Marine Ecology Progress Series, 477, pp.189-199.
8. Siddiqui, S.A., Salman, A., Malik, M.I., Shafait, F., Mian, A., Shortis, M.R. and Harvey, E.S., (2018). Automatic fish species classification in underwater videos: exploiting pre-trained deep neural network models to compensate for limited labelled data. ICES Journal of Marine Science, 75(1), pp.374-389.
9. Osgood GJ, McCord ME, Baum JK (2019) Using baited remote underwater videos (BRUVs) to characterize chondrichthyan communities in a global biodiversity hotspot. PLOS ONE 14(12): e0225859.
10. Langlois, T., Goetze, J., Bond, T., Monk, J., Abesamis, R.A., Asher, J., Barrett, N., Bernard, A.T., Bouchet, P.J., Birt, M.J. and Cappo, M., (2020). A field and video annotation guide for baited remote underwater stereo-video surveys of demersal fish assemblages. Methods in Ecology and Evolution, 11(11), pp.1401-1409.
11. Currey-Randall, L.M., Cappo, M., Simpfendorfer, C.A., Farabaugh, N.F. and Heupel, M.R., (2020). Optimal soak times for Baited remote underwater video station surveys of reef-associated elasmobranchs. PloS one, 15(5), p.e0231688.
12. Sheaves, M., Bradley, M., Herrera, C., Mattone, C., Lennard, C., Sheaves, J. and Konovalov, D.A., (2020). Optimizing video sampling for juvenile fish surveys: Using deep learning and evaluation of assumptions to produce critical fisheries parameters. Fish and Fisheries, 21(6), pp.1259-1276.
13. Jabado, R.W., Al Hameli, S.M., Grandcourt, E.M. et al. Low abundance of sharks and rays in baited remote underwater video surveys in the Arabian Gulf. Sci Rep 8, 15597 (2018). https://doi.org/10.1038/s41598-018-33611-8.
14. Zarco-Perello, S., Enríquez, S. Remote underwater video reveals higher fish diversity and abundance in seagrass meadows, and habitat differences in trophic interactions. Sci Rep 9, 6596 (2019). https://doi.org/10.1038/s41598-019-43037-5.

The following website (https://marine-sampling-field-manual.github.io/) also contains a wealth of manuals and resources for monitoring marine ecosystems, including a comprehensive chapter on BRUVS (https://benthic-bruvs-field-manual.github.io/) which can be downloaded as a pdf.

Frequently Asked Questions (FAQs) |

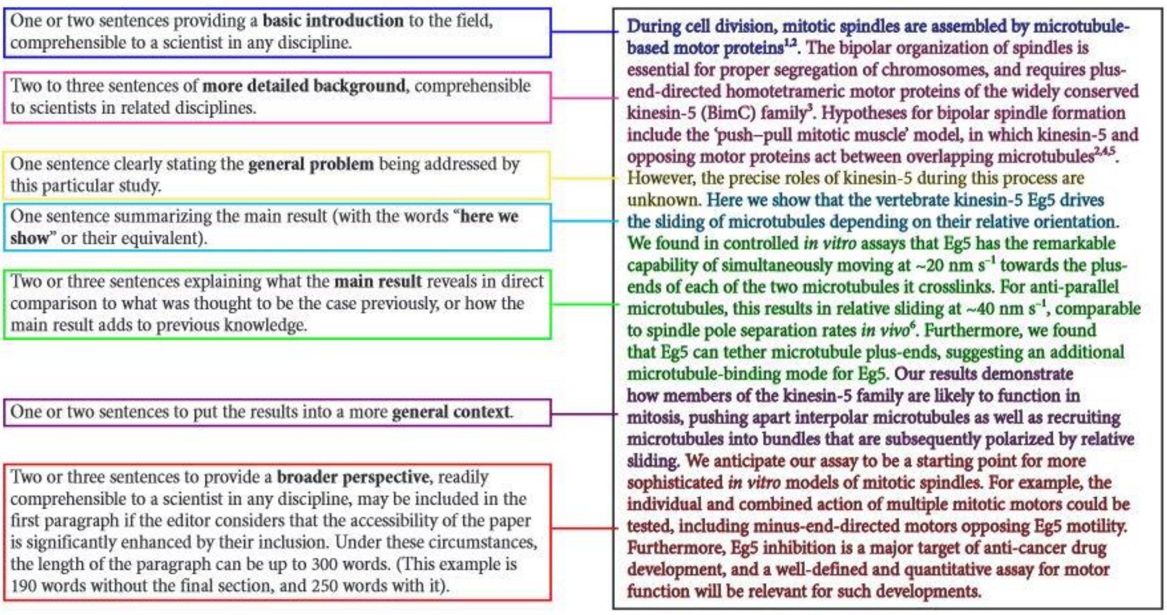
Q1. Are section headings, references in the main text, table legends and figure legends included in the word count? Yes, these all count towards the 2,000 word limit as is typical for scientific journals.

Q2. Is the title included in the word count? No, however, you should consider the following useful guidance provided by the journal Conservation Biology when coming up with a title.

> Most people will decide whether to read a paper solely on the basis of its title. Indexing and abstracting services and internet search engines also depend heavily on words in the title. And, researchers search for particular topics and then read the titles. If your title does not reflect the contents of your paper well or if the meaning of your title is not immediately clear, your paper will often not be read. Titles should be clear and concise. Do NOT use 1. hanging titles (those with a colon, dash, or sometimes a comma), 2. titles that are complete sentences, 3. headline-like titles, 4. interrogative titles, 5. titles that reference colloquialisms or popular culture, or 6. titles that contain jargon that will not be understood by our international and interdisciplinary conservation audience.

The key thing to note is that there is evidence that articles with short titles are cited more often than articles with long titles. For more information please see: https://conbio.onlinelibrary.wiley.com/pb-assets/assets/15231739/Author%20Style%20Guide%20feb2019-1551741575403.pdf

Q3. I am struggling to write my abstract can you offer any advice? Yes, if you are unsure on what makes a good abstract – see this excellent resource from Nature which breaks down an abstract into its key elements.



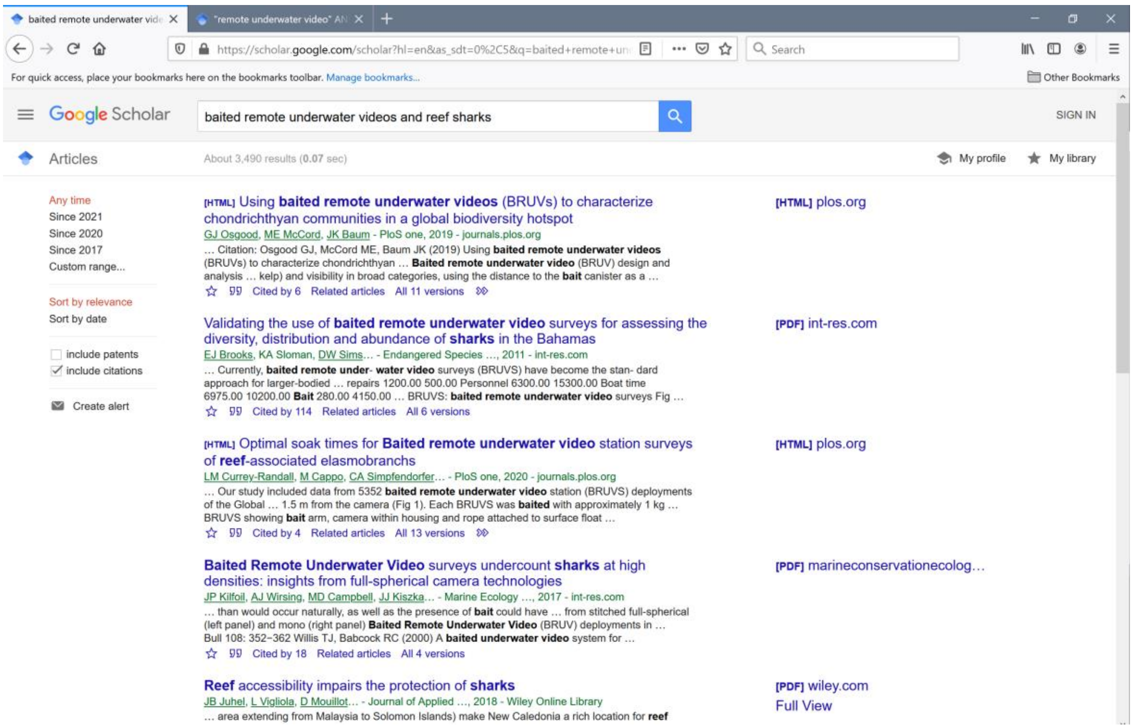
Q4. I have never written a scientific paper before; can you provide more guidance? Yes. If you want further guidance on how to write or structure a scientific paper please use the resources outlined below – these are very comprehensive. However, you will only improve and strengthen your writing skills by reading scientific papers and observing how authors structure their papers.

- https://dynamicecology.wordpress.com/2016/02/24/the-5-pivotal-paragraphs-in-a-paper/
- https://conservationbytes.com/2012/10/22/how-to-write-a-scientific-paper/
- https://dynamicecology.wordpress.com/2012/11/14/clear-writing/
- https://dynamicecology.wordpress.com/2014/06/11/how-to-write-a-great-journal-article-act-like-a-fiction-author/

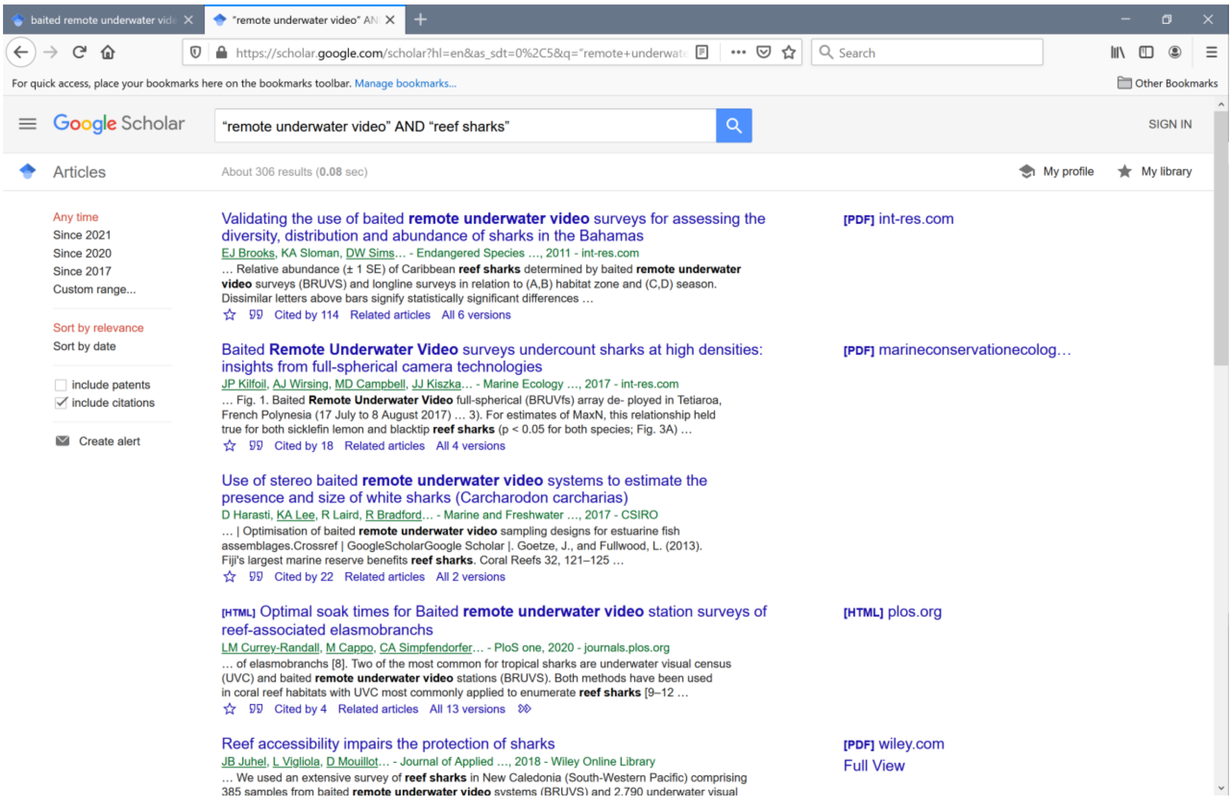
Q5. It is not clear what you mean by wider reading – can you explain? Yes – to provide evidence of wider reading and synthesis you need to provide evidence that you have engaged with the literature. This means correctly citing papers that are not included in the suggested reading, and engaging with a broad spectrum of papers from a range of authors and time period. See Q6 below on how to efficiently identify useful resources.

Q6. I am struggling to find relevant papers in Google Scholar, Scopus or Web of Science. Can you help? Yes, you can reduce the number of hits in search engines and identify more relevant results by using Boolean operators and key words or search terms (see example below).

In the first screen shot I have typed *baited remote underwater videos and reef sharks* into google scholar, leading to 3,490 relevant results.



If you wanted to reduce the number of hits you could employ Boolean searching (e.g. AND, OR). For example, if I typed “remote underwater video” AND “reef sharks” into google scholar the number of hits is reduced to 306.



For more information on using Boolean operators see these useful resources: https://uscupstate.libguides.com/c.php?g=608417&p=4474477 and https://southern.libguides.com/google/boolean

Q7. What referencing format should I use? For this assessment you should use the Harvard referencing format. Should you require further guidance please see the University of Exeter's guide to Harvard referencing: https://libguides.exeter.ac.uk/ld.php?content_id=32456245