Mapping water, and the interface of science & society

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Abstract

Community participation in environmental monitoring is changing, aiming for 2-way interactions with deeper dialogue, democratic process and wider manifestations of participatory practice. We increasingly acknowledge multiple forms of environmental data, from the numerical results of technical monitoring to oral/textual/visual narratives of traditional and/or local knowledge. We are beginning to recognise the value of co-creating science communication, not just the data collection, and understand that situating data in its local context is important for interpretation and use, as well as respect of local ownership. Effective platforms for achieving this are, however, not so well known.

Our project investigates the potential of the on-line platform ‘Story Map’ (ESRI; https://storymaps.arcgis.com/en/) for meeting these goals in coastal New Zealand communities. We describe our practice-based research in two case studies. The first case is the mapping of a collaborative project between a hapū (a local Māori tribal unit) -led marine management group and their wider community and university scientists. The East Otago Taiāpure Committee holds long-term data in many forms about the health of their marine and freshwater spaces. This includes fragmented datasets from different sources and methodologies and time periods. Compiled in context it could become valuable for informing their management decisions.

The second case includes a collaborative mapping project between local schools on the South Island and an environmental education centre, which examines the health of local river watersheds from source to sea. This project aims to combine citizen science and informal science learning (school-based) with their local communities and regional natural resource managers.

Multiple maps have been produced, which vary in nature of data, context and authorship. These are described, as well as their methodologies and functionality. We conclude with a summary of a critical discussion between multiple stakeholders about the use of Story Map. This was the focus of a dedicated workshop for local community and environmental groups, scientists, communicators, agencies and regional government, and provides a perspective on the functionality of the Story Map platform, as well as challenges for communities compiling and communicating environmental data.
Introduction

There is increasing acknowledgement that community-led natural resource management has the ability to address the current crisis our world faces with a rapidly degrading ocean (Hughes et al., 2005: Hepburn et al., 2019). Marine Customary Protected Areas (CPA’s) offer the opportunity for communities to regain their roles as guardians of their local natural resources, as they are managed through a place-based approach (Hepburn, 2019). Place-based management is a key component in managing marine resources using both Ecosystem Based Management (EBM) and the ethos of ‘kaitiakitanga’ (guardianship and protection of the environment), as it allows for those who understand and are tied to the resources to manage them (Olsen et al., 2011: Hepburn, 2019). Such management involves co-development of local fishery policies, social learning, and community involvement (Young et al., 2010). This leads to more resilient long-term planning through the provision of local and traditional knowledge, as well as the building of trust and evolving a sense of ownership for a plan (Smith et al, 1999: Moller et al., 2004: Arkema et al., 2006: Olgilvie et al., 2018). Success of a place-based management framework can be seen through the satisfaction that a community has knowing that their kaitiakitanga has actively helped with improving the health of marine resources while nourishing an environmental, social and cultural network (Hepburn et al., 2010).

The East Otago Taiāpure (EOT) is a marine CPA in Karitane, New Zealand. The Taiāpure extends 25 km and encompasses coastline, estuarine habitats and intertidal zones to a depth of 18 m, including marine resources such as cockles, flounder, yellow-eyed mullet, whitebait, and eels (Hepburn et al., 2010). The EOT is managed by members of the community through the East Otago Taiāpure Committee (EOTMC). Appointed by the Minister of Fisheries to form a partnership, half of the members belong to the local iwi, Kāti Huirapa. The other members represent scientists at the University of Otago, and community stakeholders including commercial fishers, recreational fishers, and representatives of a local environment group, River-Estuary Care Waikouaiti. The overarching goal of the EOTMC is to “acknowledge and harness different sources of knowledge while working towards the goal of maintaining and enhancing healthy fisheries habitats for the future generations, addressing threats to fisheries at a local, national, or global origin” (Hepburn et al., 2010; p 142). The EOTMC is a successful example of a partnership exhibiting place-based management to maintain a sustainable harvest for local fisheries through the use of customary management areas (specifically, a taiāpure).

The EOTMC has worked with scientists at the local university in a variety of ways. One has been through a course that is based within the EOT, in which student research addresses questions useful to EOT management, and students realise the roles and limitations of science in society through working directly with the local iwi and community to develop their research projects and report back their findings. This course is called Field methods for Assessment of Fisheries and Aquatic Habitats (offered through the University of Otago; hereafter AQFI 301). Thus far, student reporting back to the community has been via PowerPoint presentations, and the raw data collected from their research has not been archived, despite its utility for informing baseline monitoring. Indeed, a functional way to archive and share the data within wider knowledge systems has not been found that is accessible to the community. A platform for archiving and communication is needed to facilitate the wider goal of community-led natural resource management.

Our project investigates the potential of the on-line platform Story Map ArcGIS (ESRI; https://storymaps.arcgis.com/en/; hereafter Story Maps) for archiving and communication of environmental data in its local context. Accessed via web-browser, users can create a free online Story Map account, which accesses the mapping application ArcGIS. Here users have the option of creating
their own map with GPS associated data, or selecting an already made (e.g. government) map. Users can then integrate other media such as images, audio and video as data or to better explain the topic at hand (e.g. add local context). The finished site can be kept private if the data is sensitive, or can be published to share widely on the web. Relative ease of use enables one aspect of community participation. Story Map also offers the ability to hyperlink, allowing users to navigate away from the page to gain a wider understanding of the subject (Goodchild, 2007). It involves transmedia learning, where users are engaged with a story that is crafted through narrative and multiple media (Raybourn, 2014). As such, Story Map has the proven capacity to inform, educate, and involve (Marta and Osso, 2015).

Using Story Map, we aimed to produce a ‘mashup’ of interactive maps, narratives, and infographics to share and cultivate scientific data for place-based management, with a higher goal of enabling community access to local information to guide management. The following study introduces two implementations of Story Maps for facilitating such an approach to environmental monitoring and marine resource management.

**Methods**

**Introducing Story Map to the East Otago Taiāpure Management Committee**

A private Story Map account was made for the EOTMC, which required a log-in password to access. Three Story Maps were created, which contained relevant, up to date information on the state of the invasive seaweed *Undaria pinnatifida* (hereafter *Undaria*), *Anguilla dieffenbachii* and *A. australis* (eels) and *Parapercis colias* (blue cod) within the EOT. Story Maps were created using the JournalSM template to show environmental change over time, then all three Story Maps were collated using the TabbedSM template to create a central hub (see tabbed configuration Figure 1). Story Maps contained raw data from four years’ worth of AQF1301 research, related literature and local knowledge. This information was displayed via infographics, ArcGIS maps, textual narrative, hyperlinks and photographs.

The Story Maps were introduced to the EOTMC during a committee meeting (14/08/18), where the Story Maps were displayed on a projector screen, and the aims, methods, and goals of each map were described. Members were then given the log-in details to the EOT Story Map account, and encouraged to explore the Story Maps in their own time. They were also given a list of questions to contemplate for discussion that related to the utility and usability of Story Map. Only one committee member responded with an email regarding their thoughts and concerns. Two months later (16/10/18) the three Story Maps were again displayed on an overhead projector at another EOTMC meeting (nine of the 13 present having attended the previous meeting), with the aims, methods, and goals of each Story Map reiterated. This time a discussion was prompted regarding the effectiveness of Story Map to display and collate East Otago Taiāpure data. Feedback was noted at the time and summarised with the aforementioned email response.

An ESRI Story Map ArcGIS community workshop was also held in Karitane for local community and environmental groups, scientists, communicators, agencies and regional government to collectively discuss different challenges for communities compiling and communicating environmental data. The workshop consisted of a 1.5-hour introduction and presentation of existing Story Maps, including the *Undaria* Story Map made for the EOTMC, Story Map frameworks created for schools in the Aquavan program (described later), Otama Schools’ Story Map (described later), and examples of the various application templates available on for Story Map (such as CascadeSM, ShortlistSM, Swipe/SpyglassSM
and SeriesSM). This was followed with the opportunity for attendees to have hands on experience with starting to make their own Story Map by following a “how to” guide to create an EOT and rāhui boundary map using map notes, and uploading a CSV file of spatial data. It also provided attendees with the chance to talk generally and ask questions regarding community projects that they are involved with. The workshop ended with a group discussion focused on the perceived strengths and limitations of Story Map. This was recorded via voice recorder, and comments made during the workshop outside recording times were noted.

![Image of Story Map](image)

**Figure 1:** A Map SeriesSM tabbed Story Map was used to display all Story Map Journals in one place.

### Introducing Story Map for Local Management through Environmental Education

The Aquavan brings marine organisms to inland communities who may feel disconnected with their knowledge of and effect on the sea. Run through the New Zealand Marine Studies Centre (NZMSC; University of Otago) education programmes, in 2018 they implemented “Discovering Coastal Connections”, an environmental outreach programme for New Zealand South Island Primary schools. Through encountering live marine animals and engaging in hands-on scientific experiments, students (years 3-8) identified the connections of their local river from source to sea, and learned specifically how the health of their river can affect marine organisms. Story Map was introduced into the programme to encourage schools to develop their own environmental action plan to monitor the health of their local river and communicate this to their wider community.

Before each Aquavan trip, a Story Map account was created for each catchment visited, with a Story Map JournalSM template ‘skeleton’ made for each school within the catchment. Each section of the Story Map ‘skeleton’ was titled with a thought provoking question such as “How are we connected to the sea?” to encourage a discussion. Five sections were created, addressing aspects from ecosystem services that the ocean provides, to pollution mitigation schemes. Students were encouraged to add
their story through textual and multimedia components. All school Story Maps were then collated onto one catchment Map Series™ tabbed Story Map to create a hub for schools to visit and view other school’s environmental action plans. As pre-trip material, teachers were sent the log-in details for their catchments’ Story Map account, and encouraged to look through the ‘skeleton’ Story Map created for their school.

Each school’s ‘skeleton’ Story Map was presented on a projector for the last 20 minutes of the Aquavan program with the students. Here the concept of using Story Map was explained briefly, and some panels were filled out collaboratively with information students had obtained during the programme. Students and teachers were also shown how to add sections and upload pictures onto their Story Map. The expectations were explained: students were to fill out the remaining ‘skeleton’ panels during class, and create new panels that detailed an action plan relating to the health of the schools’ local river. The incentive behind completing these Story Maps was a funded trip to participate in one of the NZMSC marine science programs at their base in Portobello (generally costing ~ $240 for an average class size of thirty). Each school’s Story Map was judged based on the quality of panels, the use of multimedia, how many panels were added, and the effort behind the environmental action itself.

Results and Discussion

Feedback from the East Otago Taiāpure Management Committee

The EOTMC were appreciative of the work completed, and acknowledged the Story Maps as an effective way to display and communicate the work carried out by the AQFl301 students. In the official minutes of the first meeting, they noted the presentation of building a story map as a way of collating, presenting, and archiving information using the student field study results was “well received and showed an enormous amount of work and understanding of the value and usefulness of the information to local fisheries management”. The initial EOTMC respondent who gave feedback via email indicted that they were “thrilled to see the information in such good form, [it was] informative, concise, activated and fresh”. They were also aware of its ability to connect the students to the broader research project of the EOT: “Story Map will allow individual students to know they are part of something broader”. They acknowledged the multifaceted nature of the projects, often integrating scientific testing with local/traditional knowledge, by referring to the “world” of that research work (i.e. a “brilliantly communicated look into the world of those field research projects”.

The same EOTMC respondent also expressed concern over publishing the data online, particularly with respect to sensitive blue cod and eel data. They called for “caution around who will have access to the information [about a] vulnerable fishery” which might be put at increased risk from “adventurous” fishers, targeting the spots identified as new potential fishing grounds”. At the meetings, questions were asked about data sovereignty, including the effectiveness of the private log-in option, did the data ‘belong’ to ESRI, and ultimately, would the data be put out there for opportunist fisherman to gain benefit from. However, the idea was also raised by a committee member that having the data online is no riskier than having a scientific report fall into the wrong hands. They noted, such risk is further outweighed by the potential for such data-sharing to promote a change in the fishery and have policies be enforced, as opposed to losing the fishery altogether. A solution to using ‘risky data’ was discussed, that involved having less information carried by each data point mapped (e.g., blue cod location points should not display the GPS location, even though these data were collected).
Questions were also asked by committee members about the upkeep/sustainability of Story Map as a resource, e.g. who would be responsible for maintaining it, or creating new Story Maps when new projects arose. It was also queried whether data could be added from an external database that could be updated onto the Story Map automatically, or stripped from the map if the data owner no longer wanted the data publicly available. One EOTMC member advised that having an external database input would help the EOTMC with the continuous upkeep of the Story Maps, allowing the maps to be a ‘living resource’, and also strengthen the EOTMC’s trust in the Story Map platform.

The most enthusiastic and frequent feedback from the EOTMC was the recognition of the potential of Story Map to be used as a platform for other projects taking place within the EOT. One project in particular that was mentioned was telling the story of the necessity of the recent rāhui (closure) of the pāua (abalone) fishery around the local peninsula, which was seen as necessary for management but acknowledged as deeply unpopular to surrounding communities. A need was identified for grounding the rationale in the solid data at hand, but in a way that was nonconfrontational. The committee felt that they wanted to try using Story Map to this end.

**Feedback from Karitane Workshop participants**

Questions made by participants during the workshop mainly queried the capacity of Story Map for different purposes, e.g. “can we blog with it” and “can we draw over the top of the maps”. Although most of the workshop participants were able to start making their own Story Map and felt confident in continuing the process in their own time, it is likely that a one hour hands-on period was not long enough to fully consider the strengths or limitations of the Story Map platform. During discussion, many participants identified the potential utility of Story Map for their community projects. This included: sharing environmental information with local schools (as suggested by a representative of the national organisation Learning Experiences Outside The Classroom (LEOTC)), communicating a town environmental strategy (suggested by a Regional Council representative), including local knowledge with scientific research with regards to water health (suggested by a community environmental monitoring coordinator) and monitoring local rivers and building relationships with a community (suggested by several local high school students). One of the community environmental monitoring group representatives commented “if you have the data, but you can’t tell the story well, you’ve lost. So [Story Map] might be a tool to tell the story. Also, young people could get into that sort of technology much faster and be involved that way”. This remark was interesting because the participant acknowledged that their water quality monitoring group archive their data successfully through spreadsheets maintained by data experts that “understand the numbers”. The participant was concerned about growing what they saw as the next stage of what data means and how it can be communicated to the wider public. This suggests that the participants, as potential users of Story Map, saw it as a data visualisation or contextualisation tool more than a data exploration and archiving tool. Of particular interest to us were members of the EOTMC who attended the workshop, and were engaged during the hands-on hour experimenting with Story Map. One such member left detailed feedback via a follow-up email that expressed great interest in the potential of Story Map for their work:

“The workshop gave me the kind of afterthought/good ideas … the potential of the Story Map format could be transformative. There’s is something in it that has me seeing it as a tool to enable groups of people to work on a project, empowering young enthusiastic impatient young people to get in ‘boot and all’ to make a case, have a say - and to encourage individuals who ‘hold onto’ authority or worry about not getting it just right to free themselves from the stress of
A variety of limitations were recognised by participants. One participant raised the issue that cell phones cannot play videos in Story Maps, which brought up the concern that Story Map seems to work best on a laptop. It was recognised that this requires that Story Maps creators think about their target audience/user group and what type of device they prominently use, and thus the type of template they choose to create their Story Map. Another attendee noted that ESRI has no ethics protocol when it comes to publishing social/cultural/historical data, and that Story Map creators would have to abide by external guidelines. Another participant saw Story Map as an appropriate way to display and collate historical and current research that had been carried out in their local estuary, but expressed concern that they felt it would still take someone with a scientific background to sieve through the data so it would be formattable to upload and share with Story Map. A further data-related issue was raised by a community environmental monitoring group member who recognised that the ShortlistSM template could be a visually stimulating way to show the costs associated and background story of each of the focus sites within their region, as well as to collate local knowledge of each site, acknowledging the platform will "work with farmers, it’s not all about just data, could help tell some of the stories". However, they also recognised the limitation of having to manually enter the data into Story Map every time new data was collected. They asked if graphs automatically update Story Map when data was fed into their database. It was suggested that the group could use Story Map to link to other on-line programmes like Infogram (https://infogram.com), which would produce pie charts, bar graphs, and scatter plots, but it would still require someone manually entering the data into the Infogram website, and linking the website page to the Story Map. This is where having an external database that feeds into the Story Map and automatically updates when the data is changed would be beneficial. However, the ArcGIS Enterprise license that offers this is capacity was deemed unfeasible for small scale community groups (with an approximate/variable cost of $7,500 US per license).

Discussion also focused on the potential stumbling block for teachers and students to complete even preformatted ‘skeleton’ Story Maps (as described subsequently for the Aquavan project). It was debated how much of a skeleton template should be made in order for schools to be able to usefully display their information, e.g. including placeholders for photographs, websites, and other transmedia so that schools might be able to realise the potential of Story Map and then change the pictures/transmedia to their own content. It was argued that students and teachers would still need an adequate amount of time to ‘play around’ with the Story Map website to be confident in using it for even these purposes. Generally the idea of the ‘skeleton’ template was positively received, with a participant involved in community environmental monitoring coordination overtly expressing interest in using the Aquavan ‘skeleton’ template to collate and display invertebrate data that their students have found at different monitoring locations. Indeed, several local high school students participating in the workshop expressed particular interest in learning more about Story Map as a communicative tool to display data from their work monitoring their local rivers, as well as detailing other environmental monitoring projects within their community (as one put it: “to get what we do out there more”), and in particular to help build a relationship between the school and the wider community. These students also saw links between Story Map and their school curriculum, noticing work with the application could potentially contribute towards Information and Communications Technology (ICT) credits in high school. Overall, there was consistent enthusiasm expressed by attendees to use Story Maps for their projects. Two Story Map workshop attendees were so interested that within one month of the workshop they had allocated directed funding for environmental monitoring projects to be augmented via Story Map.
Feedback from Schools involved in Environmental Education

Using the Map SeriesSM tabbed Story Map application to combine different school’s Story Maps worked well for connecting schools within each catchment. As part of the programme, some studies were run by Environment Southland and NZMSC staff that involved a few schools in detailed studies of an estuary study and an inland stream. These two studies were also documented in the composite tabbed Story Map, allowing schools that didn’t participate in these studies to view the research that took place. It also reiterated the concept of a catchment connecting from the mountains to the sea, as each school’s Story Map represented a different location within the catchment. Due to being displayed as a live web-page, the Story Map Journals automatically updated on the Map SeriesSM tabbed Story Map when edited, keeping the collective work contemporary and a 'living' resource.

From feedback forms collected by the NZMSC, it was clear that teachers thought the concepts taught through the Aquavan program were useful to their teaching curriculum. However, engagement with the Story Map element of the programme was less than hoped for. Only one of the 13 schools completed their Story Map to a high standard. This, the Otama school in the Mataura River catchment, built a narrative and multimedia-rich Story Map that detailed their environmental action plan (https://www.arcgis.com/apps/MapJournal/index.html?appid=2054bda14f914319be586b1f1b7e156c). Their Map included:

- Skeleton panels filled out (in response to the ‘provoking questions’)
- A photo essay titled “Look” that investigated objects students found surrounding their river (mainly rubbish)
- Letters to the local District Council (and the replies they received) detailing local environmental issues such as rubbish, possum traps, river pollution and irrigation
- Video interviews of students and their thoughts about their river health
- Community surveys and interviews of Otama locals about the health of their river
- Stop-motion videos detailing the connections between the mountains, river and sea
- Articles about farming and the environment
- A letter to community members regarding river health and community action Recycling efforts including methods of creating Beeswax wrapping and methods for making a tukutuku kite (plastic free)
- River and Ocean themed poems
- Stories about Marine animals
- A hand drawn map of the journey their river takes to the sea, with corresponding picture graphs (which is going to be made into a mural to put onto their bus shed).

Although this school successfully used narrative and multimedia in their Story Map, the only geographic maps displayed were those that were already created for the ‘skeleton’ template. This suggested that the teacher/students were able to navigate Story Maps to choose a pre-made map to display, but perhaps making new spatial/geographic maps with ArcGIS was not within their ability. Indeed, the data mapping (e.g. through linked ArcGIS spatial maps) was distinctly underutilized in the Aquavan Catchment project, and we felt it would be utilized more fully if GPS-associated environmental data was collected at different time points by the schools. However, it takes a lot of preparation and effort to provide schools with capacity to collect such environmental data. There was also very little preparation in regard to introducing Story Map, or ArcGIS mapping in schools, and there was no effort made to introduce the application into the school curriculum. Strachan (2014) identified similar obstacles to
Successful implementation of Story Map, including a need for additional training (by schools and in particular teachers), and lack of time. Franklin (2007) also identified barriers for teachers using computers in schools, such as access and availability, preparation and training, leadership, and time. Story Map is a readily accessible online platform, however there was some confusion with teachers even over the log in details. To overcome these technical barriers, it has been recommended that preparation programmes are offered to teachers that involve using ArcGIS and Story Map as teaching and learning tools (Strachan, 2014). The Aquavan program now intends to produce a description of how Story Map can be used (with the log-in details fully explained) to allow teachers to become familiar with the software and expectations of the project. Scheduling Aquavan trips further in advance is also anticipated to allow teachers preparation time for the environmental action project, and to make connections between Story Map and curriculum links such as literacy, ICT, sustainability and science. Strachan (2014) advised that local professional GIS users provide ongoing technical support to teachers looking to use GIS and Story Maps in their classrooms, however this is less feasible in rural New Zealand where it is unlikely that a professional GIS technician would live in the small towns that the Aquavan visits. There may, however, be opportunities to tie the Aquavan program in with ArcGIS student learners at the Otago University.

It should be noted that only the Story Map JournalSM template was introduced to schools as a framework to complete their Story Maps with. Perhaps an application that relies more heavily on narrative and multimedia as opposed to mapping would be more appropriate, such as the CascadeSM template. The appeal of CascadeSM is that the template allows immersive sections that fill the whole screen with sections containing text and in-line media. This would take pressure off including mapping within the classroom. The last section of Otama schools’ Story Map contained a photograph that the students had drawn of the Mataura River with corresponding pictures at significant locations (Figure 2). Story Map has a template that could produce a similar outcome which the schools were not introduced to. ShortlistSM presents places of interest organized into tabs (Figure 3). Schools would be able to connect an area on the river with a photograph, and a description of that area. Perhaps schools would be more inclined to describe their environmental action plan if they had more freedom in how to tell it, e.g. in picking templates as opposed to, as in this case, being given a ‘skeleton’ made with Map JournalSM. However this would require more preparation time by teachers in selecting a suitable template.
Figure 2: Picture included in Otama Schools’ final section of their Story Map. A hand drawn map of the journey the Mataura River takes through their town with corresponding pictures. This could be replicated using Story Maps’ ShortlistSM template.

Figure 3: Example of the ShortlistSM template which spatially organises places of interest.
Conclusions

Successes of Story Map

Through our own personal use of Story Map in making the prototypes for this study, and from the feedback we collected, we identified multiple advantages of using it as a platform for community-engaged environmental monitoring and place-based resource management. These included its accessibility as a free multimedia website generator that is easy to share online (via a URL or the social media buttons embedded onto the site), enabling swift spread of knowledge via virtual communities. Its templates are user friendly and regularly updated. But most importantly it links seamlessly with basic access to the spatial mapping application ArcGIS, which normally has to be purchased and downloaded for use.

The prototype Story Maps we generated for the EOTMC were perceived by them to work well as a way of “collating, presenting and archiving information” in an “informative, concise, activated and fresh” way. More importantly, it was recognized that it created a platform that allowed for the collation of fragmented data (e.g. across gaps in collection years, or different methodology), which is often associated with community-engaged management, including citizen science and student research. Further, being able to frame community-led research (in this case, guided by tanga tiaki, or guardians of the local area) as a narrative alongside rich map visualizations and transmedia not only made the data more meaningful and approachable, but also functioned to deepen the information and empower pride and local cohesion. For those contributing various forms of data, from students to teachers, local community members and tangata whenua, it is important for them to know they are part of something bigger. This is key to community engagement in local environmental monitoring and stewardship, and crucial for the success of place-based management.

Limitations of Story Map for Community Use, and Further Recommendations

When introducing Story Maps into schools, we used the ‘build it and they will come’, approach with having premade ‘skeleton’ Story Maps. However, only one of twenty-three schools actually completed their Story Map. This suggests there is still a stumbling block when it comes to schools using a ‘foreign’ technology within a limited time frame. To combat this, it is suggested to hold Story Map/ArcGIS workshops for teachers to overcome the barriers outlined previously. Story Map should also be linked with curriculum including ICT, sustainability and science. Ideally, to use Story Map most effectively for community engaged environmental monitoring within schools, an environmental action plan is needed that involves long term, spatially related data monitoring that students can record, map and contextualise. However, in many instances this would require a lot of outside support (from programmes like the Aquavan) or a highly engaged community supporting the school. Story Map in its most basic form might serve as one way for growing such an engaged community, connected to both their natural resources and their student learners via local transmedia story telling. Eventually this might expand to allowing for environmental monitoring data to be compiled and communicated in a visually stimulating way such as via interactive maps.

Although a private log-in can be used to limit access to a Story Map, data privacy remained a concern for members of the EOTMC with regards to some of their already vulnerable fisheries resources. The CSV files uploaded to create their Story Maps are stored in the ESRI cloud. The free Story Map subscription does not allow for files to be uploaded via a web file but the ArcGIS Enterprise subscription allows data to be uploaded via Dropbox (protected by an obscure URL), which will automatically update the map when the file is updated, and can be stripped from the map when the data owner no longer
wants the data displayed. As such, the data is stored in own’s own cloud, not ESRI’s. Another limitation with the free Story Map subscription is there is no ability to share the stories as ‘view only’ within a delimited group; any person who has the log in details will also be able to edit the maps. This was not perceived as an issue within the EOTMC but could be within other organizations who don’t want their data public but would like the data shared within their organization. Again the ArcGIS Enterprise subscription has a solution to this, allowing the option to create different roles including ‘viewers’, ‘user-viewer’, ‘publisher-user’, and ‘administrator-publisher. However, as previously described, even the cost of one license is unfeasible for a community group to purchase.

Upkeep of the resource was another limitation identified by the EOTMC, with internal questions about who would be expected to keep the maps updated as new research takes place and thus concern about the sustainability of the resource. Manual input and specific formatting of data is required for spatial display. If in future, if an ArcGIS template was available for raw data collection that was formattable for Story Map, this would allow data to be uploaded straight to the Story Map with little effort or data manipulation skills required. Further, in making the prototypes for the EOTMC, many decisions had to be made in terms regarding how to visualize the data, as Story Maps is not naturally a data exploration tool. For example, when entering data with the same GPS location, the data points stacked upon on another (as opposed to being displayed individually when zoomed in on). To accommodate this, GPS points were ‘jittered’ (altering the GPS locations by 0.00001 degrees latitude/longitude), but due to the small spatial scale between sampling locations for the Undaria, blue cod, and eel Story Maps when using the ‘Count Size’ option, data points still overlapped. This meant data had to be displayed alternatively via heat maps and infographics, or further averaged. Realistically, this means that displaying significant volumes of environmental monitoring data on Story Map requires background knowledge of the science and data being displayed, and the communication skills to know how to display such data within its wider context. At its most intensive and refined level of use, it entails an ability to use appropriate design principals, to link to relevant external background information, to summarise text and sometimes scientific terms/methods, as well as skills in photography and videography. Undoubtedly this could be the job of a professional, or several, however it is not outside the realms of skills that could be sourced from within communities. Despite its limitations, the enthusiasm we found expressed by a wide body of future users, from teachers to students, agencies, central government and local iwi, is indicative of Story Map’s potential in community environmental monitoring and natural resource management.
References


