

So You Want to Make a Film: An Introduction to Creating Videos for Broader Impacts in Fisheries and Aquatic Sciences

Andy J. Danylchuk*, Campbell Morgan, and Nichole Ring, Department of Environmental Conservation, University of Massachusetts Amherst, 160 Holdsworth Way, Amherst, MA 01003. *Corresponding author e-mail: danylchuk@eco.umass.edu

INTRODUCTION

Today's society has greater access to video media than ever before (Duffy 2008; Mulhern 2009). The rapid expansion of the Internet (Web 2.0) in the 1990s followed by the proliferation of smartphones and tablets in the early 21st century have put people across the globe in front of screens not just capable of text and photos but also video in a range of formats. For instance, approximately 77% of adults in the United States currently own a smartphone (Pew Research Center 2018) and 68% of smartphone owners get news from their phones (Pew Research Center 2015), much of which is presented as video content. The attention span of consumers of online media products has been reduced to small bites of information, and a story conveyed in video format can add greater depth to the subject matter in a condensed amount of time as compared to other formats. Stories conveyed through video media also have the benefit of catering to an audience that absorbs information visually, rather than via text (Duffy 2008). This is reflected in the fact that the video media platform YouTube is estimated to be the fourth largest Internet site in the world (Liu 2010) and that it offers audiences a way to watch videos as well as the means for individuals and organizations to share video content that they create themselves (Welbourne and Grant 2016). Similarly, social media platforms such as Instagram and Facebook provide platforms for users to share experiences using video media. There are also some Web-based portals (e.g., Vimeo Plus, YouTube) that allow amateur and independent film producers to self-distribute, market, and monetize their video productions.

Alongside the proliferation of platforms for sharing video media content, high-definition digital video cameras and video-editing software have become affordable and accessible, allowing nonprofessional filmmakers to share stories and information through video media. Companies such as Go Pro (Go Pro Inc., San Mateo, California) not only provide users with ways to capture video media via video cameras but also create software (Quik Desktop and Fusion Studio) that allows video content to be easily edited and shared through the Internet and social media (Struthers et al. 2015). The action-camera market, in particular, has helped remove barriers that once limited users to capturing video media in extreme settings, such as underwater, where the investment and risk to traditional video equipment would be quite high (Struthers et al. 2015). Overall, greater accessibility to an audience, in addition to economical and efficient ways to capture video media, has resulted in a new wave of independent video media

producers wanting to share a stories and information for a wide variety of reasons.

Sharing of information related to science, technology, engineering, and mathematics (STEM) disciplines is particularly enhanced by video media (Aysan 2015), and many scientists are beginning to embrace video media as a way to communicate their research. In fact, science and nature are facets of our world that lend themselves well to this video media revolution (Anderson-Wilk 2009). Video media can transform the complexities of science and nature into something more tangible and tractable, and bring the vast web of life to a level that people can relate to (Karppinen 2005). From atoms to the atmosphere and ocean depths to mountain peaks, video media already has a track record of bringing science and nature to a home audience. Think back to the days of Jacques Cousteau, *National Geographic* of the 1970s and 1980s, and Mutual of Omaha's *Wild Kingdom*, where the raw natural world and scientific innovations were considered both educational and entertaining. However, with the proliferation of video media in the 21st century, discoveries in sciences and nature are able to reach an audience faster than ever before, potentially increasing the capacity for science literacy worldwide. With greater demands placed on scientists to demonstrate the broader impacts of their research (Andrews et al. 2005; Cooke et al. 2017), video media is proving to be a popular and effective tool (Karppinen 2005).

Video media may be especially relevant for sharing information and increasing the broader impacts related to fisheries and aquatic sciences (Monroe et al. 2009). Given that humans do not live underwater, it might be more difficult for the public to understand how fish and other aquatic organisms make a living, grasp the complex nature of aquatic ecosystems, and develop an appreciation about how human activities can negatively impact aquatic systems and their inhabitants. Although video media can be an effective and exciting mode of communication in fisheries and aquatic sciences, there are many caveats that should be considered before academics and agencies consider including video media productions in their broader impacts and associated education and outreach campaigns (Monroe et al. 2009; Struthers et al. 2015). The de-professionalism of video media production and the proliferation of the Internet, smartphones, and social media are almost forcing scientists and resource managers to become part of the video media revolution (Claussen et al. 2013); however, keeping up with the expectations (i.e., demands) of their potential audiences related to the format and quality of video media

may influence the actual effectiveness of videos that they use for education and outreach (Welbourne and Grant 2016). The purpose of this paper is to provide academics and agencies in fisheries and aquatic sciences with some fundamental perspectives and tips related to video media production, especially as the demands for using this form of science communication for education and outreach increases. Based on our collective experience as scientists using video media for broader impacts, we also share tips that will, hopefully, help others avoid some pitfalls and produce videos that they are pleased to share.

STAGES OF VIDEO PRODUCTION

Creating a video media product can be compartmentalized into three main segments—preproduction, production, and postproduction. Even for the simplest video, partitioning the process into these discrete segments can help ensure that the story you want to convey is structured in such a way as to maximize its effectiveness, and that you do not overlook any pieces of the story when filming so that you are not forced to restructure or change the message if you are missing important content in the editing phase. Regardless of the content, it is important to remember that even as a scientist, the goal is to tell an engaging story. And although the story may be clear in your mind, it is important to put yourself in the position of an audience that may not have shared the same experiences, series of events, and emotions. This makes planning a video production even more important, and compartmentalizing the process into preproduction, production, and postproduction can help. In short, preproduction is the phase needed to draft a story line, decide on how you are going to capture the images, and plan the video shoot(s); production is the process of actually capturing the story on video; and postproduction is all the editing and processing after the footage has been collected to actually create a final product. How much time and effort you want to or are realistically able to put into each stage can greatly determine the cost and desired effectiveness of your video.

Preproduction

Preproduction is one of the most important stages of video production, and more time and effort here will increase the success of your video. In this stage, you will be deciding what you want your video to be about, how much you want to spend on your video, what your video will be used for, and who you want to see it (among many other questions). This process is very planning-intensive, and we have developed a series of questions to ask yourself during the preproduction phase that can make the video production process more efficient and better match your own expectations to the final product (Table 1). It is important to answer the questions honestly and realistically and even consider having someone ask you these questions since you will be more likely to recognize potential bottlenecks and constraints as you verbalize the answers. It is also important to consider this an adaptive process, meaning that if you are unable to get the results you want with the amount of effort or funding you have, you can revisit each question and make adjustments along the way. Last, consider using these questions if you are producing a video for someone else since it is important to ensure that everyone is on the same page regarding each stage of video production.

Two of the most important questions to ask during the preproduction process are (1) why are we making a video and (2) why does it need to be made now? For instance, will the

Table 1. Important questions to consider during preproduction of a video media project.

Primary question	Related questions and considerations
Why do you want to make a video?	<ul style="list-style-type: none"> • Could still images and/or text suffice? Why not? (e.g., material is too complex)
What do you want to say with your video?	<ul style="list-style-type: none"> • What do you want the viewers to do once they watched your video? • Does it need to be said now? Why? (e.g., part of a presentation, capture a unique event, as part of broader impacts meet sponsor criteria, to obtain funding)
Who do you want to see your video?	<ul style="list-style-type: none"> • Interested public, stakeholders, investors, peers
How will you distribute your video?	<ul style="list-style-type: none"> • Lab Web site, Internet (e.g., YouTube), social media (e.g. Instagram), conferences, film festivals
How long does the video need to be?	<ul style="list-style-type: none"> • Full-length documentary, multiple videos, short video
Who will make your video?	<ul style="list-style-type: none"> • You, you and other colleagues, you and your students, you will hire someone
Do you currently have or are willing to invest in the necessary equipment?	<ul style="list-style-type: none"> • Appropriate cameras, lenses, tripods, sound equipment, lighting equipment, media storage and backup, editing software
How will you pay for the video?	<ul style="list-style-type: none"> • Discretionary funds, current or apply for grant funding, crowdsourcing, donations, in-kind support
How will you attract people to watch the video?	<ul style="list-style-type: none"> • Word of mouth, social media, formal marketing campaign
How will you gauge the success of your video?	<ul style="list-style-type: none"> • “likes” and tone of comments on social media, audience survey

video highlight a time-sensitive or time-structured event? If so, then compromises may need to be made regarding the ability to quickly mobilize and capture enough footage to piece together a video before the event ends. In cases like this, it will be important to quickly amass resources, enlisting additional videographers to collect prime shots and supporting images (i.e., B-roll). If what needs to be filmed happens with some regularity or you have more or complete control over the events, then you may have time to plan the process, including potentially doing the actual production when all the resources are in place. Regardless of the topic and timeline, however, it is important to understand why your story should contextually be told now and where your narrative fits into current events. This will allow you to then shape the tone of your video production so that it will resonate with the audience and maximize viewership.

Understanding your audience is important to determine how technical and complex the dialogue and imagery needs to be. This will change dramatically depending on if the video is for the general public, school children, or other scientists. When thinking about your audience, it is important to get into their heads and imagine what they would need to see and hear to understand your message both visually and auditorily. For instance, will your audience be more engaged by seeing individuals being interviewed as a way to capture first-hand accounts and expert opinions of events or would they prefer a greater proportion of action shots and scenery with an audio narrative (called “voice-over”). Depending on the demographics of your audience, would they prefer smooth transitions between individual video clips and melodic music or more

dramatic, fast-paced transitions and upbeat music? Although much of this may be determined with an educated guess, not putting thought into the tone of your video production may end up driving away viewers, even if the content is of interest.

Intertwined with these broader conceptual considerations are questions associated with who your audience will be and how they will access your video production. Knowing where your audience usually finds videos to view as well as their viewing preferences (e.g., free short video clips, pay-per-view full features) will help you optimize the distribution outlet for your finished product. In turn, defining the audience and path for distribution will help determine the ideal duration for the video, as well as the resolution and quantity of the video content and associated sound needed for production. In some cases, it might be more effective to offer your video production as a series of short, sequential clips or chapters rather than a single, long video. For instance, if you plan to use your video as an introduction to your aquatic sciences lab and have it be on the landing page of your Web site, it might be more engaging if the production was a relatively short summary (<3 min) so that it inspires viewers to spend more time exploring your Web site rather than a lengthy video that provides details that may not be relevant to all viewers.

The length of your video greatly affects the cost and amount of time you have to put into it. As a rule, shorter is almost always better; it is the most cost-effective option and will get the most interest since people are more comfortable making a commitment to watching a video that is under 3 min, especially if you are planning on putting your video on the Internet or social media Web sites. Longer videos will take more time and potentially need more people and more money to produce.

As for image quality, not long ago, filming at a resolution of 1,080 (high-definition video at 1,080 lines of vertical resolution) was common, especially since this was the maximum resolution at which audiences were able to view video content. More recently, however, video cameras (even some incorporated into smartphones) are able to capture footage at a resolution of 4K (4,096 × 2,160 lines or 3,840 × 2,160 lines, depending on screen aspect ratio), and similarly, 4K computer screens and TVs have become more available at lower costs. Additionally, video media outlets such as YouTube and Vimeo are now able to upload and distribute 4K content, giving viewers the option of selecting the ultra-high-definition format or downscaling to a lower resolution depending on bandwidth.

Determining who will actually be making the video will dictate equipment needs, the learning curve for using the equipment, and how much you will need to budget in terms of time and money. This should also include time and effort needed in postproduction, as it can be demoralizing when the video content you captured cannot be processed efficiently and with the level of quality that you and the proposed audience are expecting. In some cases, it might be more effective to hire an editor and other technicians (e.g., sound engineer) during postproduction who can do in days what nonprofessionals do in weeks or months. When it comes to equipment, depending on the format, locations, and tone, you might need to invest in a video camera, as well as sound equipment, light sources, and accessories such as tripods and underwater housings. If you can anticipate making video productions a part of your regular broader impacts, then it might be worth purchasing all the resources you need. However, if this is your first time with video production, you may want to search for

a collaborator that could share existing resources, or consider renting the equipment you need. Many universities are also establishing video media labs where faculty and students can sign out equipment at little to no cost.

How you will pay for the video production is an important question to address. If you are putting a video media production in a grant proposal as part of broader impacts, it will be critical to accurately budget for the equipment and technical labor you will need; otherwise, you may find yourself not being able to produce the type of video production promised to financial sponsors. Although it is often appealing to enlist students to help with video productions because of their enthusiasm and potentially lower cost, your projected timeline may fall outside of academic semesters or require more fulltime, consistent attention than undergraduates with a full schedule of classes can commit to. These and other important considerations take time and it might be important to track the number of hours you are putting into preproduction since it could be more significant than you think. Nevertheless, the more time you put into preproduction, the greater the likelihood that you will avoid potential pitfalls and end up with the video you expected to produce.

Before jumping to the production phase, and regardless of the reason and type of video you want to produce, it can be very helpful to draft a treatment, storyboard, and shot list to ensure that you stay true to your story and get the footage you need (see Sidebar 1). A treatment is a way to put your story to text, including the intricacies of the scenes and the subjects. Treatments are generally written in the present tense and include a title, a log line (1–2 sentence description similar to what you may find in *TV Guide*), and a synopsis (1–3 pages or more). Although it may go against the more systematic, concise mindset of scientists and academics, you should try to incorporate feelings and emotions into the treatment, as well as how segments of the story are linked by potential dialogue and interviews. Think of the images you hope your audience will see, and describe how they will convey pertinent information as well as keep the audience engaged. From the treatment, consider using a storyboard to help sketch out the images you would expect the audience to see when telling the story. Even stick figures can be useful for sketching out the sequence of scenes and for graphically organizing your ideas. With a treatment and storyboard in place, it can be much easier to compile the shot list that will make sure you end up with the video content you need to tell the story you laid out in the treatment.

For your shot list, make sure to include your primary footage (e.g., interviews, focal subjects, and scenes) as well as B-roll. Think of B-roll as the video clips that allow the viewer to better understand the context of a scene, including details of what your subjects are doing or of your subjects transitioning between scenes and actions. Also consider the B-roll as a way to capture events at a range of visual scales, from wide-angle scenery shots that could help introduce the viewer to a specific location to close-up footage of a hand as it adjusts the zoom knob on a microscope before the image of a sectioned otolith from a fish is shown to the audience.

If you plan to do any interviews for your video, take the time in preproduction to draft out a series of questions to ask. Since your subject might be nervous about being interviewed, keep your questions relatively short and be specific about what you hope to hear. It is also useful to start the interview with a few easy questions to allow the subject to become comfortable with the setting and having the camera directed at them.

Sidebar 1

Example of a treatment (including log line), storyboard, and shot list for the first in a series of mini-documentaries on low-head dams removals in New England. Shot type key for the shot list is EWS, extremely wide shot; VWS, very wide shot; WS, wide shot; MS, medium shot; MCU, medium close up; CU, close up; and ECU, extreme close up.

TREATMENT

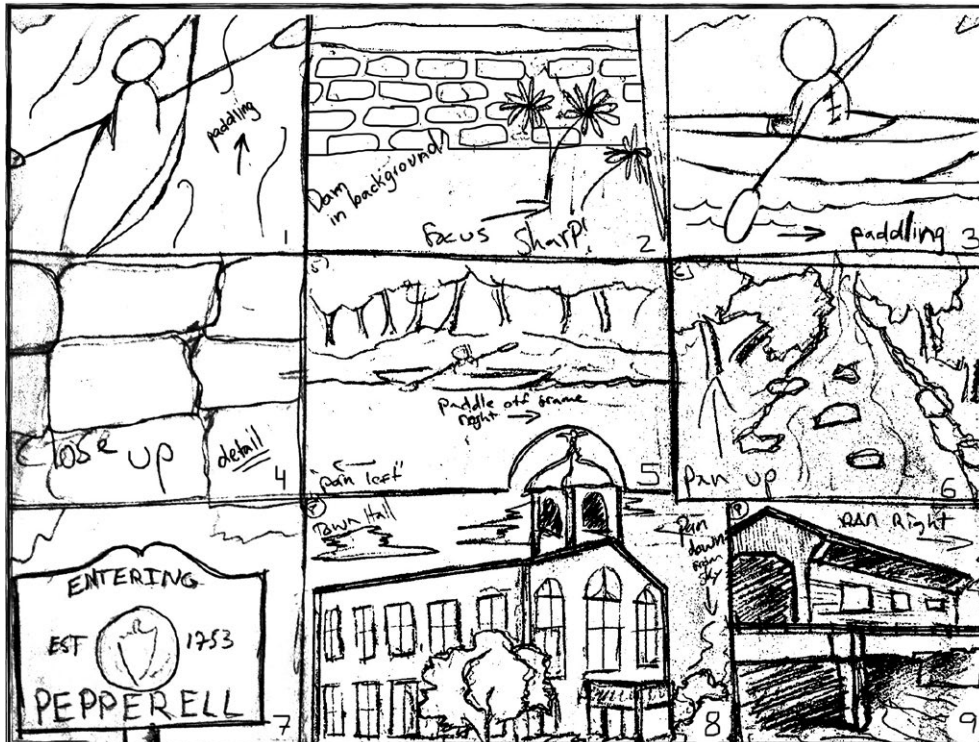
Working title: Dams Down East Part 1
 Location: Massachusetts, rivers, dams
 Video length: 2–3 min (as part of a series)

Log line: We follow the story of dam removal in New England through the eyes of a woman who spent most of her life advocating for river conservation and protection.

Start: Sounds of a kayak paddling can be heard over a black screen. A woman's voice chimes in with laughter. Woman is kayaking away from camera, her voice continues, as she

explains how the river's health relates to her own health. The dam comes into the frame, sharp-focused flowers in foreground, the dam is out of focus in background. Cut away back to the woman, she is smiling and laughing, and continues to speak about the association between the river's health and her own. The camera goes back to the dam and shows the details in the rocks. Once again the camera returns to the woman in a kayak, paddling, fall foliage in background. Cut to slow pan up; facing up river, fall foliage in full color, the woman's voice-over ends, talking about body and spirit, fade to black. Cheerful music starts, cut to "entering Town" sign. Cut to pan down from clear blue sky to the Town hall and then the covered bridge..... [End]

STORYBOARD



SHOT LIST

Shot #	Location	Shot type	Comp	Description
1	River	Pan up	WS	Woman paddling downstream
2	Dam	Slow pan right	MCU	Start facing dam, dam stretches across frame, end shot with flowers taking up right third of screen
3	River	Still	WS	Woman paddling to the left, whole body and canoe in shot
4	Dam	Still	CU	Dam details, stones, cracks, structure, etc.
5	River	Pan left	VWS	Woman paddling on river, river and forest are in view
6	River	Pan Up	EWS	Facing downriver, dense trees are on the side.
7	Town	Still	CU	Sign with town name
8	Town	Pan down	VWS	Dam as seen from above (cutting river in half)
9	Town	Zoom out	Start: WS End: EWS	Town bridge over river, starts with half of structure in view, zoom out to see whole structure

Depending on how you are planning to distribute your video, you may also consider or even need formal permission (either in writing or on camera) from the subject that they agree to being interviewed and to their dialogue being used for your production. The same may follow for certain locations and subject, especially children. Nothing could ruin the outcome of a video production more than legal action taken against you and your employer regarding the use of unauthorized footage. It is highly likely that you will also need permission to film in places like national parks, some public places, and other countries. If you have the time, consider visiting the potential locations ahead of actual production to obtain authorization, and also appreciate site-specific nuances that you may need to consider when filming.

Production

The production phase is when the video and audio assets will be collected according to the planning done during the preproduction phase. Although it is not always possible to stick to a schedule, having an outline to guide you through the production phase will be essential once you start amassing video content. Also, the amount time and effort spent on planning during the preproduction phase will have an impact

on how easily and quickly you will complete the production phase and how good the quality of your footage is.

Collecting stable footage and clear sound is critical regardless of the purpose and outlet of the video production. Even if high-resolution images are not needed and a lower-quality video camera can be used, having stable footage, crisp audio, and proper lighting will save a considerable amount of time and effort in postproduction. This even applies to video content obtained using a smartphone and intended for social media, especially if it is important to grab and maintain the attention of viewers. When recording footage, using stabilization devices such as a tripod can help you make sure you have the best chance at getting clear content (Figure 1). Even just resting the camera on a steady surface can make the difference between quality and shaky footage. Also, once the camera is set up on a stable surface or stabilization device, it is important to regularly monitor the screen to make sure that it has not shifted focus or that the subject is still where you want it to be. When shooting underwater footage, get to know the underwater camera housing before taking it out in the field. Make sure the lenses have properly adjusted to the temperature before putting them into the housing in order to avoid condensation and completely unusable footage. Placing desiccant packets in



Figure 1. Images of video crews making productions related to fisheries and aquatic sciences, highlighting the use of equipment to optimize image stability. (A) Using a slider to stabilize images of a stream while also adding slight lateral motion to the footage, (B) using a shoulder support rig to help stabilize footage during a bumpy boat ride, and (C) and (D) interview set-ups using cameras on tripods and remote sound, with (D) using an additional camera for a diversity of angles on the subject.

underwater camera housings can also help prevent issues with condensation.

Whether above or underwater, being cognizant of lighting is important. If shooting outdoors, a good rule of thumb is to shoot at dawn and dusk and avoid midday for the best-looking shots. If that is not possible, make sure the light source is behind the videographer to ensure that your subject is illuminated and to avoid a backlit shot. If shooting an interview, consider acquiring an inexpensive lighting kit or inexpensive do-it-yourself lighting options found on the Internet. Lighting is an important variable when it comes to creating strong visual assets. Simply shifting your position may be the difference between an outstanding shot or dark and unclear footage.

Audio is also an important asset collected during production. Even if the piece is visually stunning, poor audio is distracting and can take away from the story. When collecting audio for the project, consider using an external microphone that is close to the subject and storing the audio on a separate file. If interested in making a more refined piece, it is also important to gather a 30-s clip of the audio from the shooting location; this is known as the room tone and can be used to repair audio in postproduction. This is an important step if you are looking to create a refined piece, especially if you are looking to outsource the editing process.

For interviews, finding a comfortable and quiet location will make the subject potentially more at ease and will also help ensure good audio quality. Factors such as the type of location and time of day can influence the degree of distractions, background noises, and even the energy level of the subject. Asking the subject the easiest questions first can make them more comfortable in front of the camera and ease them into the conversation, especially if they are not media-trained. You may need to ask the subject the same question in a slightly different way or to ask the question multiple times until your interviewee feels confident with their response. If time permits, allow the subject to take a break from being in front of the camera, especially if they begin to appear agitated or frustrated. Having a comfortable interviewee is key; it can mean the difference between insightful and interesting dialogue and unusable sound bites.

If the dialog desired for the piece was not obtained during shooting, it is always possible to use voice-overs. Voice-over is a production technique where a voice is recorded separately and added over the visual assets of a film in order to explain the story. The voice-over is usually recorded after the bulk of the production stage is completed and can be used to fill in some of the gaps in content. Voice-overs can be read from scripts and can allow multiple takes as they are usually shot in a controlled environment and are ideal if you need additional audio material to explain the story. To record a voice-over, it is best to step into a vocal booth to reduce echo and increase the quality of the sound. If this is not possible, make sure to record audio in a room with minimal echo; blankets or heavy cloth may be hung to absorb noise. A walk-in closet can also be used to record a voice-over.

Regarding assets, as many professional video producers can attest, you can never have enough B-roll, especially since it may be difficult to go back to a specific location to reshoot a scene or event requiring you to rely on the extra footage you captured while shooting if you have problems with some of your primary footage. Additionally, collecting an abundance of B-roll can be beneficial to future projects, especially since there will likely be a lot of footage that does not make it into the final video media product.

An important habit to get into is to back up footage on primary and secondary hard drives as soon as possible after it is collected, just as you would for your scientific data. There is nothing more devastating than losing video and audio assets due to human error (e.g., accidentally erasing a memory card) or if the only hard drive used for media storage fails. Even during postproduction, it is important to back up your project files regularly. Consider at least two separate hard drives to store the assets gathered during production, and keep these drives in separate locations to ensure the safety of the footage.

If funding is not available to purchase a camera, tripods, lighting, and sound equipment, many schools, universities, and libraries will have these resources available to rent or borrow for little to no cost to students, faculty, or residents. If that is not an option, a diversity of equipment can be rented from commercial sources so that the video and audio assets obtained during production do not impede the story to be constructed in postproduction.

Postproduction

After gathering all the footage and backing it up on multiple hard drives, it is important to catalogue the assets and potentially create transcripts of interviews. After hours of filming in the field, there can be much more content than is needed for the production, and developing an efficient way to remember what was obtained will help with storytelling. To get an idea of what shots and sounds are available, you must go through and review the content. Begin by setting up various folders that correspond to the project(s) at hand. If you are making a single film, try starting with a few folders with names such as “B-Roll” and “Interviews.” While reviewing content, place files that you like in corresponding folders for later compilation. Well-organized folders will increase workflow and efficiency during the postproduction process. This set can be very labor-intensive, especially if there is a large amount of footage to go through. As such, it is important to remember to include this step in the preproduction phase (in the budget, staffing, and time allocation); otherwise, it may cause a delay in postproduction.

Oftentimes in the scientific community, interviewees will have immense amount of information on a subject and plenty of good dialogue and sound bites to go with it. Transcribing interviews and creating a word document will allow you to review sound bites from an interview, without having to rewatch all the footage. This also allows you to easily isolate the files that contain the sound bites that will be used in the film. When reviewing interview footage and transcribing, be sure to label transcription with the video file number so that you can locate the desired sound bites later. Without proper labeling, it may be very difficult to link your transcribed document to a specific video file for later compilation. Interviews may run for quite some time and be stored as one video file, so locating a single sentence can be a time-consuming process. To speed up the process, tag desired sound bites with the video’s time code when transcribing.

Once there is a collection of usable video and audio, the process of editing the film can begin. There are multiple video-editing programs on the market today, and the abilities range from simple slideshow animation to professional video editing. The learning curve can be less with more basic software packages such as iMovie (Apple Inc., Cupertino, California); however, the features and flexibility to edit and (especially) clean up footage can be limited. More complex programs such as Adobe Premier Pro (Adobe Systems Inc., San Jose, California) and Final Cut Pro (Apple Inc.) will allow a wider

range of manipulations but can require some time to learn to use. Take time to work with editing software before you even begin filming and consider taking online editing tutorials or introductory classes. YouTube has thousands of free editing tutorials that can teach everything from simple editing techniques to complex video manipulation.

Once the video and audio assets are obtained and cataloged, it is time to edit it all together into a cohesive story. After importing all the footage into an editing program, begin to craft the video based on the treatment and storyboard you created in preproduction. If you have not created a storyboard or treatment, this step will take longer and require more attention. Consider starting with interview clips and accompanying audio, since this will build continuity in the story via specific sound bites. With a skeleton of the film laid out, B-roll can be added to embellish the story and bring life to what the interviewees said. Gaps in the story can be filled with voice-over narration and supporting text and graphics, such as maps, pictures, and animation. At this stage, you may find that your original treatment and storyboard goals may be unattainable or in need of modification based on what was captured. For instance, you may have planned for a specific shot that was not able to be captured or that is simply unusable due to technical issues such as focus and lighting. Sometimes, interview locations are not ideal and important audio dialogue is corrupted from noises such as traffic and distant conversations as well as the echoes and the humming of electrical appliances or laboratory equipment in the background. Less-than-ideal video and audio content might be salvageable through functions in the editing software. For the more basic programs (e.g., iMovie), the ability to stabilize, crop, recolor footage, and filter out unwanted audio might be limited, meaning that investing in more advanced editing software might be necessary to optimize the digital assets you have. For field research in fisheries and aquatic sciences, trips to the locations might be inherently bumpy and underwater footage too blue or underexposed, requiring the use of many more advanced features of editing software than when filming in a laboratory or when having options for where an interview can be conducted.

Although professional editing software packages can have built-in functions to correct for imperfections in video and audio content, there can be elements of your production that are difficult to salvage. For instance, even though there are many program presets to help reduce echoes and some noises in audio, fixing poor audio can be very complex and require a deeper understanding of digital audio. In such cases, it might be necessary to seek the services of a professional sound engineer or to consider adjusting the story so that narration via voice-over of the video content can make a segment of the story usable. The same goes for adjusting the overall color and contrast of the video production to avoid certain scenes from being dark or to avoid dissimilarities in color hues for clips from the same location because of changes in camera angles or sudden changes in lighting. When done correctly, these modifications can greatly enhance your video's quality. Providing continuity between clips in regards to light and color will make your film more cohesive, rather than just a series of clips strung together. If music needs to be added to the film, it will also be important to consider where it is sourced and how it is integrated with the video footage and dialogue. There are a growing number of royalty-free music sources online, some of which require payment to access and use while others can be used without any financial investment. It is important, however, to make sure to

read the fine print related to the contractual obligations of using even royalty-free music. Failure to abide by copyright laws can result in the video being removed from the Web or, worse, a lawsuit by the original owner/creator. In some cases, it might be safer to budget for a composer to create a musical score for the project, which will ensure ownership and the freedom to distribute and even monetize the production.

SUMMARY

All the above factors and nuances can make the filmmaking process frustrating, but through careful preparation and planning, it is possible to join the video media revolution and create a video production that enhances education and outreach for fisheries and aquatic sciences. Through the considerations and tips covered in this paper and via other sources, we hope that some of the pitfalls and challenges in video media production can be avoided so that the final product meets your expectations and that of your intended audience. Demands and access to video media will surely continue to grow, especially as the use of the Internet and availability of smartphones increases, including in the developing world. As such, it will be necessary to remain flexible and adjust expectations about video media as a tool for effective science communication (Cooke et al. 2017).

Science communication will continue to evolve beyond journals and printed material and use videos embedded in Web sites and on social media as a way to reach a broader audience in the digital age. Video-based scientific journals are beginning to emerge (<https://www.jove.com>), creating more avenues and opportunities for a broader audience to learn, understand, and appreciate science and its applications. This is especially true for applied fisheries and aquatic sciences, where the end goal is to positively affect change in human societies, including collective decisions regarding use, management, policies, and legislation that will create a sustainable future for aquatic ecosystems.

ACKNOWLEDGMENTS

We are greatly indebted to Ted Caplow, Joe Cunningham, and Sarah Curry for sharing their knowledge, passion, and experience related to filmmaking. We are also thankful for the insights and cooperation offered by Doron Schlair, Stewart Cullpepper, Mark Peterson, Javier Mayol, Sascha Clark Danylchuk, Michael Philipp, Kyle Philipp, Trent Phillip, Tom Porter, Dave Stewart, David Jacobson, Greg Hamilton, Brian Bennett, Grant Wiswell, Curtice Griffin, Steve Goodwin, Catherine Portuges, Beth Karlin, Nikunj Kapadia, Chris Haak, Karly Tobias, Kim Ovitz, Lauren Mack, and Tyler Gagne. Funding for our filmmaking experiences was provided by Fish Navy Films, the Allen Family Foundation, Whiting Foundation, Philipp Family Foundation, the Massachusetts Division of Ecological Restoration, and the Science Media Collaborative. The Department of Environmental Conservation, College of Natural Sciences, Interdepartmental Film Studies Program, and Isenberg School of Management at the University of Massachusetts Amherst also offered support. There is no conflict of interest declared in this article.

REFERENCES

- Anderson-Wilk, M. 2009. Changing the engines of change: natural resource conservation in the era of social media. *Journal of Soil and Water Conservation* 64:129A-131A.
- Andrews, E., A. Weaver, D. Hanley, J. Shamatha, and G. Melton. 2005. Scientists and public outreach: participation, motivations, and impediments. *Journal of Geoscience Education* 53:281-293.

- Aysan, E. 2015. Learning science and science education in a new era. *Annals of Medicine and Surgery* 4:158–161.
- Claussen, J. E., P. B. Cooney, J. M. Defilippi, S. G. Fox, S. M. Glaser, E. Hawkes, C. Hutt, M. H. Jones, I. M. Kemp, A. Lerner, S. R. Midway, S. Nesbit, J. Osborne-Gowey, R. Roberts, and C. Steward. 2013. Science communication in a digital age: social media and the American Fisheries Society. *Fisheries* 38:359–362.
- Cooke, S. J., A. J. Gallagher, N. M. Sopinka, V. M. Nguyen, R. A. Skubel, N. Hammerschlag, S. Boon, N. Young, and A. J. Danylchuk. 2017. Considerations for effective science communication. *FACETS* 2:233–248.
- Duffy, P. 2008. Engaging the YouTube Google-eyed generation: strategies for using Web 2.0 in teaching and learning. *Electronic Journal of e-Learning* 6:119–130.
- Karppinen, P. 2005. Meaningful learning with digital and online videos: theoretical perspectives. *AACE Journal* 13:233–250.
- Liu, Y. 2010. Social media tools as a learning resource. *Journal of Educational Technology Development and Exchange* 3:101–114.
- Monroe, J. B., C. V. Baxter, J. D. Olden, and P. L. Angermeier. 2009. Freshwaters in the public eye: understanding the role of images and media in aquatic conservation. *Fisheries* 34: 581–585.
- Mulhern, F. 2009. Integrated marketing communications: from media channels to digital connectivity. *Journal of Marketing Communications* 15:85–101.
- Pew Research Center. 2015. US smartphone use in 2015. Available: <http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015>. (February 2018).
- Pew Research Center. 2018. Mobile fact sheet. Available: <http://www.pewinternet.org/fact-sheet/mobile>. (February 2018).
- Struthers, D. P., A. J. Danylchuk, A. D. M. Wilson, and S. J. Cooke. 2015. Action cameras: bringing aquatic and fisheries research into view. *Fisheries* 40:502–512.
- Welbourne, D. J., and W. J. Grant. 2016. Science communication on YouTube: factors that affect channel and video popularity. *Public Understanding of Science* 25:706–718. [AFS](#)