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Captain and Observer Perspectives on the Commercial Viability and Efficacy of Alternative Methods to Reduce Seabird Bycatch during Gear Haulback in the Hawaii-based Pelagic Longline Swordfish Fishery

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1. INTRODUCTION

Bycatch of seabirds in longline fisheries threatens the viability of some populations (Anderson et al., 2011). Seabirds are primarily caught while longline gear is being set, and as a result, seabird bycatch mitigation research has appropriately focused on methods to reduce seabird captures during setting and not hauling (Brothers et al., 1999; Gilman, 2011; Clarke et al., 2014).

Since 2001, when requirements to mitigate seabird bycatch during setting in the Hawaii-based longline shallow-set swordfish fishery came into effect, seabird catch rates and levels declined by about 90% (Gilman et al., 2014). Now, about 75% of bird captures occur during gear haulback (Gilman et al., 2014). An average of about 59 seabirds (±9 95% CI) was annually caught during gear haulback in the fishery between 2011 and 2015 (Gilman et al., 2014; NMFS, 2012, 2013, 2014, 2015, 2016).

There are about 20 active vessels in the Hawaii shallow-set longline swordfish fishery (NMFS, 2015). The fishery operates year-round, with the majority of effort occurring between February and April. Vessels fish at grounds in the North Pacific typically between 130^{o} W to 180^{o} longitude and 22^{o} to 40^{o} N latitude (summarized in Gilman et al., 2014). A study conducted in 2014 analyzed observer data and identified methods that significantly affect seabird bycatch during gear haulback in the Hawaii longline swordfish fishery (Gilman et al., 2014).

Building off of the 2014 study, we interviewed Hawaii longline swordfish captains and conducted a demonstration of a method designed to reduce seabird interactions during gear retrieval. Study aims were, globally, to fill a gap in knowledge of effective and commercially viable methods to mitigate seabird bycatch during haulback in pelagic longline fisheries, and locally, to identify commercially viable solutions that may enable substantial reductions in seabird haul bycatch rates in the Hawaii longline swordfish fishery. Current fishing mortality levels of Laysan and black-footed albatrosses in the Hawaii longline swordfish fishery are very unlikely to pose a risk to these two species at the genetic population level (Laysan albatross estimated absolute abundance has been stable, and there has been an increasing trend in black-footed albatross estimated absolute abundance, ACAP, 2014; IUCN, 2016). Further reductions, however, would directly contribute, albeit slightly, to remediating the cumulative effects from anthropogenic mortality sources, including removals in other pelagic and demersal longline fisheries operating in the north Pacific. Further reductions would also improve fishing efficiency, as it is economically and operationally inefficient to catch, handle and release alive and discard dead seabirds.

2. METHODS

Between December 2015 and April 2016 we interviewed ten Hawaii longline vessel captains with experience conducting shallow-sets to target swordfish in order to obtain their input on alternative methods to mitigate seabird bycatch during gear retrieval (Appendix 1). The captains' responses were used to select the most promising method that was then employed during three fishing trips to document the method's economic viability, practicality and safety.

During interviews, which required about 30 minutes to complete, captains were asked to provide comments on eight methods that might reduce seabird captures during hauling. We asked captains to comment on each method's practicality, safety, economic viability, and likely effectiveness at avoiding the capture of seabirds during hauling.

Considerations for practicality included ease for crew to deploy, retrieve, and store on deck, and how use of the method might affect normal hauling activities. Considerations for economic viability included whether the method might damage catch, cause catch to be more difficult to retrieve, damage the gear, or affect the quantity or degrade the quality of market catch in any other way. And, considerations for safety included whether use of the method pose any risk to crew safety. Furthermore, captains were asked to describe any methods that they have used in the past to attempt to avoid seabird interactions during hauling, whether there are additional methods or combination of methods that would be worth considering, and which method they would select to use, if they had to use a bird avoidance method during hauls when seabirds were present.

The seabird haul bycatch methods included in the captain interviews, and hypothesized effect on seabird haul bycatch rate, are described below.

- **Bird curtain**: A pole with streamers attached that are of a length that enables them to drag on the sea surface in the absence of wind and position so that the streamers are in an area where baited hooks come to the sea surface during gear haulback. The design was adapted from one prescribed for use during gear setting developed by Nigel Brothers (Fig. 1) (Brothers and Gilman, 2006; Gilman et al., 1997; NMFS, 2005, 2010). When used in combination with side setting and branchline weighting, significant reductions in seabird catch rates during setting occurred in Hawaii longline fisheries. The mechanism for efficacy of the bird curtain has been hypothesized to be because the curtain prevents scavenging seabirds from getting into a flight pattern that brings them close to the vessel hull where they might have access to baited hooks during setting (Gilman et al., 2008, 2016).
- **Towed buoy**: Towing a buoy or other object astern has been used to mitigate seabird bycatch during setting (McNamara et al., 1999) and hauling (Gilman et al., 2014).
- **Maximized crew branchline coiling rate**: Having crew manually retrieve the monofilament branchlines and coil them into branchline bins during gear haulback as quickly as possible, so as to minimize the amount of time that baited hooks are near the sea surface and away from protection by the vessel hull, may reduce the risk of seabird captures during gear retrieval (Gilman et al., 2014).
- **Refrain from flicking spent bait from branchlines during hauling**: When crew flick the branchline in order to dislodge spent bait from hooks in the water during coiling, the bait ends up in the area where subsequent baited hooks are coming to the sea surface, attracting scavenging seabirds to the area where they are most susceptible to capture.
- **Attaching weighted swivels close to the hook**: In some pelagic longline fisheries, fishers attach weights to pelagic longline branchlines in order have the branchlines orient downwards and deeper in the water column during the gear soak, especially in rough weather (Beverly et al., 2003). Branchline weighting designs also affect the sink rate of the baited hook during setting and concomitant accessibility to seabirds (e.g., Robertson et al., 2013) and may also

affect the accessibility of baited hooks during gear haulback (Gilman et al., 2014). The smaller the weight and the further the weight is located from the hook, the more time it takes for the weight to affect the baited hook sink rate and concomitant availability to seabirds during setting. Similarly, with increasing branchline weight and decreasing distance between the weight and the hook, the more likely the weighting design will reduce the availability of baited hooks to seabirds foraging at the sea surface during haulback (Brothers et al., 2001; Robertson et al., 2010; Gilman et al., 2014; Gilman and Hall, 2015).

- **Position crew coiling branchlines further forward on deck than the length of branchlines**: On vessels with a deck layout that permits adjusting crew positions during hauling, positioning crew coilers so that the distance between the coiler position and the stern is $\geq$ the branchline length (mean branchline length in the Hawaii longline swordfish fishery is 10.9 m) would reduce the likelihood of having baited hooks trail astern during coiling, so that baited hooks are protected from scavenging seabirds by the vessel hull (Brothers et al., 1999; Gilman et al., 2014). Shorter branchline length has been observed to significantly reduce standardized seabird catch rates, including during hauling (Gilman et al., 2014), suggesting that reducing the length that branchlines drag astern might reduce seabird haul catch rates.
- **Adjust vessel hauling speed**: Having the captain set the vessel speed during hauling sufficiently slow that crew can keep up with coiling branchlines as they come up on the mainline, and address tangles in the gear, will reduce the likelihood of crew temporarily leaving branchlines with baited hooks untended (clipped to the rail or to a 'lazy line' trailing from the vessel stern) (Brothers et al., 1999; Gilman et al., 2014).
- **Water spray**: Rigging a nozzle to spray a strong jet of water over the area where baited hooks come to the surface during hauling might deter seabirds from entering the area, or conceal the baited hooks from being observed by seabirds during gear haulback, thereby reducing the seabird haul catch rate. Brothers et al. (1999) described trials of a water cannon device to reduce seabird bycatch during setting, similar to the method that could be used during gear haulback, the main difference being that the area where baited hooks are vulnerable to seabird interactions is substantially smaller during pelagic longline gear retrieval.

We decided not to include a bird-scaring *tori* line as one of the alternative haul seabird mitigation measures. Unlike during setting, vessels stop frequently during hauling for a variety of reasons (e.g., entanglements, mechanical failures, weather conditions, crew needing food and bathroom breaks). This causes the aerial portion of the bird scaring line to become slack and drop to the sea surface where, if deployed over the area where baited hooks come to the sea surface during hauling in order to protect the baited hooks from scavenging seabirds, the tori line might become entangled with the fishing gear. This possibility was confirmed during the captain interviews.

Some RFMOs require retaining all fish, offal (fish parts) and spent bait during fishing operations to reduce the likelihood of attracting seabirds to the vessel and causing competitive scavenging behavior. Other RFMOs require "strategically" discharging bait and offal from the opposite side of the vessel from where gear is being set or hauled to attract scavenging birds away from baited hooks (Gilman et al., 2014b). We did not include strategic discards in the demonstration project because there have been mixed findings of the effect on seabird catch rates from intentional strategic offal discards. Refraining from discharge may be more effective over the long-term (Cherel et al., 1996; Brothers et al., 1999; McNamara et al., 1999; Gilman, 2011).

Some vessels in the Hawaii longline fishery dye bait blue in order to meet seabird bycatch regulatory requirements, a method that has been demonstrated to result in large and significant reductions in seabird catch rates during setting (e.g., Gilman et al., 2016). This reduces the contrast between the bait and the sea surface as viewed by seabirds when foraging from above. Gilman et al. (2014) found no significant difference in standardized seabird haul

catch rates between sets using dyed vs. untreated bait, possibly because the treated baits retained little dye following ca. 9 hour-long gear soak times. Based on these findings we decided not to include blue-dyed bait as an option for use in the demonstration.

Finally, Gilman et al. (2014) explained why use of an automatic branchline coiler was not included as an option in the demonstration component of this study:

> "An automatic electric branchline coiler (known as snood pullers for demersal longline vessels)…would have the potential to reduce the time required for crew to retrieve branchlines relative to manual retrieval, and hence reduce the time that baited hooks are available to scavenging seabirds. Automatic coilers were historically used in the Hawaii longline fishery when traditional basket-style gear with tarred rope was used, before transitioning to monofilament gear. With the modern gear, manual coiling into bins may be more efficient and be less likely to result in branchline tangles during setting than using automatic coilers (Jim Cook, Hawaii Longline Association, personal communication, 15 Nov. 2012)."

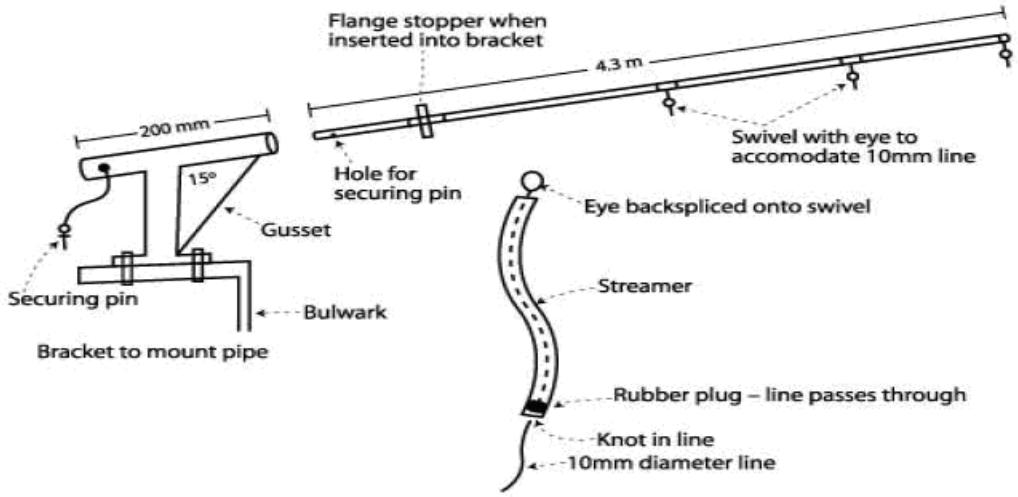

Fig. 1a. Schematic of a bird curtain design developed by Nigel Brothers and adopted in US regulations for use during side setting in the Hawaii longline fisheries (Brothers and Gilman, 2006).

Fig. 1b. Installing a bird curtain for use during setting. Top left: attaching the streamers to the pole by either eye splicing through the 13 mm hole in the aluminum tab on the pole, or onto a stainless steel clip. Top right, attaching the streamer to the pole. Bottom left: knot holding the hose in place, either backsplicing or heat sealing the end of the streamer. Bottom right: a deployed bird curtain for use during side setting (Brothers and Gilman, 2006).

F/V Quynh Vy, a 22 m long longline vessel that conducts both shallow- and deep-sets, participated in the demonstration project to trial the use of a bird curtain during gear haulback during 34 hauls over three trips. The three trips were conducted between 23 October 2016 and 10 Jan. 2017. Captain Tim Nguyen and three federal government-placed scientific observers, Erin Emanual, Tom Pham and Evan Casey, completed surveys (Appendices 2 and 3) at the end of each trip. The bird curtain deployed during hauls during the commercial demonstration is shown in Fig. 2. The stainless steel pole was 4 m long, inserted into a pole and secured with a pin, located on the stern-starboard corner of the roof of the bait shack. The pole was parallel to the sea surface when deployed. Two ropes were attached to the end of the pole and secured to the vessel deck to adjust the position and constrain the range of motion of the pole when deployed. The pole swung about ±2 m side-to-side during gear haulback. During trip 1 the bird curtain had three streamers with garden hose used as a sleeve over the bottom 1 m section of the streamers. During trips 2 and 3, two streamers were used, with PVC sleeves in place of the garden hose.

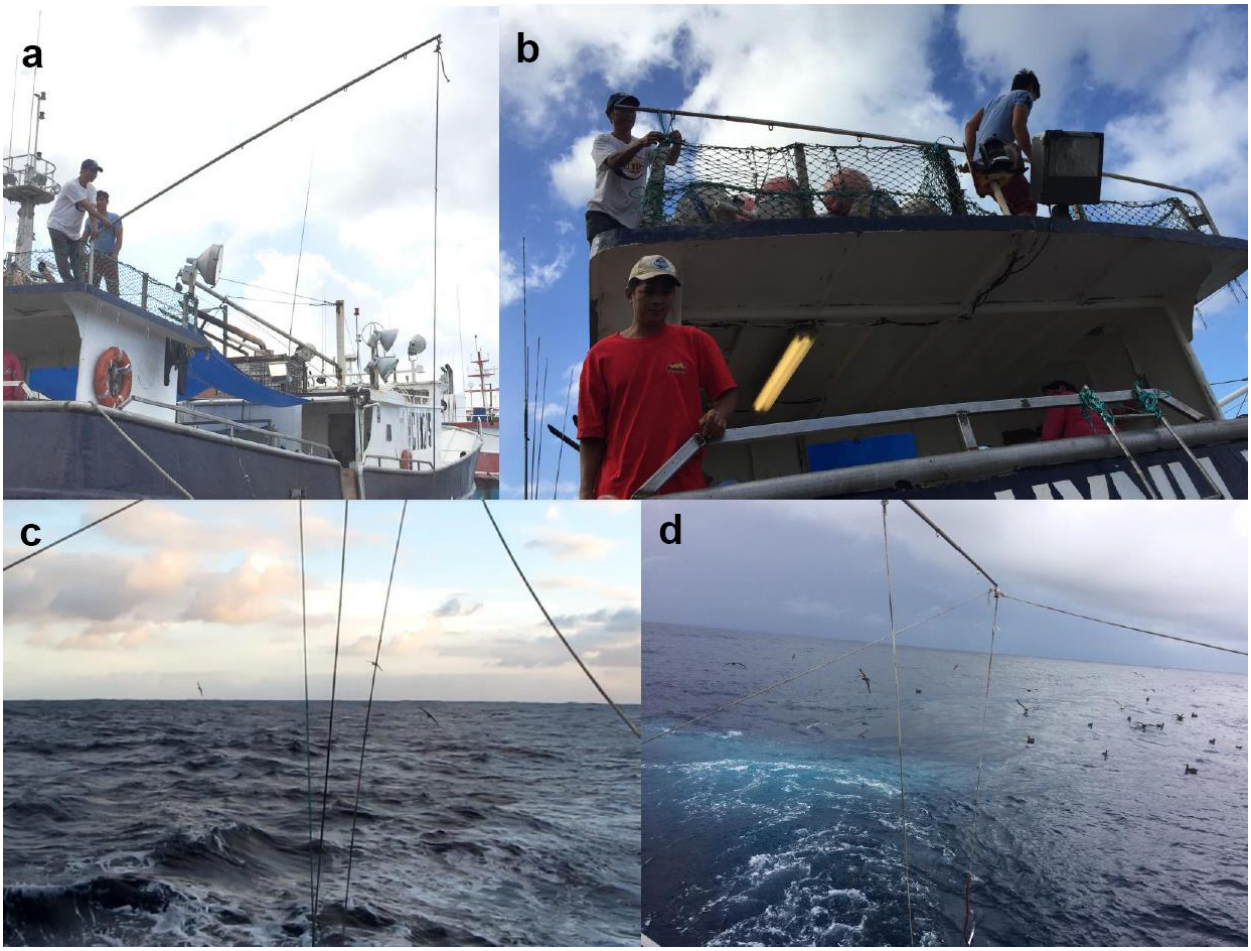

Fig. 2. Bird curtain used during gear haulback on Hawaii longline F/V Quynh Vy. (a) Being installed on the roof of the bait shack, (b) stowed position, (c and d) bird curtain deployed.

3. RESULTS - CAPTAIN INTERVIEWS

Section 3.1 provides information on the captains that were interviewed, and the other sections paraphrase captains' responses to the survey questions. The number of captains that made a given response is indicated for all responses (N=x).

3.1. Captains Interviewed

Ten captains were interviewed during the study. The captains had an average of 22.7 years (range 10 to 29 years) participating in the Hawaii longline fishery.

3.2. Bird Curtain

Responses follow to questions related to using a bird curtain over the area where branchlines are retrieved when seabirds are present.

Practicality: It would not be difficult to construct, deploy, retrieve and store it when not in use (N=8). It would not likely entangle with the gear or affect hauling operations (N=9). It would likely entangle with the gear and interfere with our retrieving caught swordfish, for example, when we use a grappling hook (N=1)

Safety: It would not pose a safety risks to crew (N=9). It could pose a safety risk if it tangles with the gear and catch (N=1).

Economic viability: It would not affect economic viability including damaging the catch, causing catch to be more difficult to retrieve, damage the gear, or affect the quantity or quality of market catch in any way, or affecting gear hauling operations (N=9). It could reduce economic efficiency if the bird curtain makes it slower to retrieve our catch and gear (N=1).

Effective at avoiding seabirds during hauling: It would probably be effective (N=8). It might be more effective than a bird scaring *tori* line that we have used during hauling in the past because, unlike the tori line (see section 2.10), we could deploy the bird curtain directly over the area where hooks are coming to the surface, if it could be made long enough, without risking entanglement with the gear when we stop the vessel during hauling (N=5). When there are high winds, when we used a bird curtain during side setting, the streamers blew towards the deck and did not work at keeping seabirds away from the side of the vessel hull where we were setting. The same problem might occur when using a bird curtain during hauling (N=2).

3.3. Towed Buoy

Responses follow to questions related to deploying a towed buoy in the area where branchlines are retrieved when seabirds are present.

Practicality: It would not be difficult to construct, deploy, retrieve and store it when not in use (N=6). It would likely entangle with the gear if it were deployed directly over the area where branchlines are being retrieved (N=9). But if it were deployed near but not over the area where branchlines are coming to the surface, then it would not likely get entangled with the gear (N=5). Based on past experience, a towed buoy can occasionally tangle in the prop, in addition to sometimes tangling with the gear (N=2).

Safety: It would not pose a safety risk to crew (N=7). It could pose a safety risk if it tangles with the gear and catch (N=1).

Economic viability: It would not affect economic viability including damaging the catch, causing catch to be more difficult to retrieve, damage the gear, or affect the quantity or quality of market catch in any way, or affecting gear hauling operations (N=7). It could reduce economic efficiency if the bird curtain makes it slower to retrieve our catch and gear (N=1).

Effective at avoiding seabirds during hauling: Yes, it would be effective (N=8). It would reduce seabird haul bycatch but not as effectively as a bird scaring line or bird curtain (N=5).

3.4. Branchline Coiling Rate

Responses follow to questions related to crew maximizing their branchline coiling rate when seabirds are present.

How could crew increase their branchline coiling rate? Some crew members can be inattentive and coil relatively slowly, especially at the end of the trip when they are tired. The captain can ask them to increase their coiling rate when he notices this is occurring (N=6.). Paying the crew more money could get them to coil faster by giving them more motivation (N=1, DG). When crew members are not occupied processing fish on deck, then the captain can have them assist with coiling, which can avoid having branchlines pile up (N=1). There is no space to have additional crew assist with branchline coiling, and usually the rest of the crew are too busy with other assigned activities (N=4). We do not find crew coiling slowly to occur on our vessel (N=3).

Practicality: It is not practical to get crew to coil faster than the status quo (N=4). It is feasible for crew that are inattentive to coil faster (N=6). And this is beneficial to all the vessel operators: If the crew coil faster, then we can get the haul completed more quickly, which means more time for crew to have free time, for sleeping, eating, etc. (N=1).

Safety: Coiling faster does not pose a safety risk (N=10).

Economic viability: Coiling rate has no effect on economic viability (N=5). It might improve economic viability to coil branchlines faster, as this allows for a quicker haul, which in turn might allow for more hooks to be deployed per set (N=4). It is not economically viable to pay crew more to give them a larger incentive to coil faster (N=1).

Effective at avoiding seabirds during hauling: This can have a big effect on bird bycatch during hauling (N=2). This can be effective (N=5). I do not know (N=2). When crew coil slowly, the baited hook can drag on the sea surface where it is available to seabirds to get caught. Slow coiling can also can result in getting backed up with processing branchlines, resulting in crew clipping some of the branchlines to the rail or a lazy line where these untended branchlines can create a risk for bird capture (N=7).

3.5. Flicking Spent Bait from Hooks

Responses follow to questions related to having crew refrain from flicking spent bait from hooks during hauling when seabirds are present.

Practicality: It is practical to not flick bait off the hooks (N=10). My crew already do not flick bait from the hooks (N=6). My crew very infrequently will flick spend bait off hooks during hauling (N=3). Now that we are required to use only fish for bait, it has become very difficult to flick the spent fish bait off the hook, and therefore crew rarely flick bait off of hooks (N=4). It is much harder to flick mackerel off hooks than saury (N=1). Crew members do not do this because the NMFS onboard observer does not permit it: We are only supposed to discharge spent bait on the opposite side of the vessel

from where we are hauling (N=1). Crew remove spent bait from hooks only after they retrieve the branchlines on deck (N=9).

Safety: Not flicking bait off hooks has no effect on crew safety (N=10).

Economic viability: It has no effect on economic viability (N=10). It might take slightly longer to have crew remove the bait from the hook after retrieving the branchline, but this has likely a very small effect on the haul duration (N=4).

Effective at avoiding seabirds during hauling: Not flicking baits off hooks might reduce bird bycatch during hauling (N=5).Not flicking baits off hooks would have no effect on bird capture risk during hauling because the seabirds are already actively scavenging in the area where baited hooks are being retrieved (N=1). I do not know (N=4).

3.6. Attaching Weights Close to the Hook

Responses follow to questions related to attaching weighted swivels closer to the hook. Fishers attach branchline weights an average of 6.6 m from the hook in the Hawaii longline swordfish fishery (Gilman et al., 2014).

Practicality: Location of the weighted swivel on the branchline would not affect practicality in any way, including affecting hauling operations (N=8). It would be impractical to locate the weighted swivel closer to the hook than we currently locate it (2 fathoms from the hook) because my crew will grab the hook to help them cut the branchline close to caught sharks – if the weight were any closer to the hook, the crew wouldn't be able to use this method to release sharks (N=1).

Safety: We attach weighted swivels about half-way (N=5) or about one third of the way up from the hook (N=3) on our branchlines when swordfish fishing. We could move it a little bit closer to the hook, at most about 10 feet (3 m) (N=3), or at most 3 feet (1 m) (N=5) from the hook. But I would not place it any closer because of concern of weights flying back at the vessel at high velocity when the branchline breaks or is cut when under high tension during hauling, such as when a shark bites through the leader or a fish throws the hook (N=7). Placing the weight closer than about 2 m would make it unsafe to cut branchlines close to sharks (N=1). Yes, placing weighted swivels closer to the hook could be safe, e.g., if wire leaders are also used (N=1).

Economic viability: The location of the weight on the branchline does not have an effect on economic viability (N=4). We would not want to locate the weighted swivel in between the lightstick and the hook. We want the section of branchline with the lightstick to move around in the water. If we placed a weight near and below the lightstick, this might reduce its movement. We currently use 80g weighted swivels, and locate them about midway on the branchlines. We attach lightsticks about 2 feet from the hooks (N=4).

Effective at avoiding seabirds during hauling: I do not know (N=1). Yes, it would be effective (N=5). It would probably be effective (N=4).

3.7. Deck Position of Crew Coilers

Responses follow to questions related to adjusting crew position on deck when coiling branchlines into bins during gear haulback. On vessels with a deck layout that permits adjusting crew positions during hauling, move the position of coilers so that the distance between the coiler position and the stern is $\geq$ the branchline length (mean branchline length in this fishery is 10.9 m, Gilman et al., 2014). The objective is to avoid having baited hooks trail astern during coiling, so that baited hooks are protected from scavenging seabirds by the vessel hull**.**

Practicality: My crew when coiling stand far forward near the fish door at the hauling station, so we are already far enough forward that hooks do not drag astern (N=1). Due to our vessel deck layout we lack room to move crew much more forward (N=1). It is not possible to move the coilers further forward because they need to be positioned to receive the clips from the captain as he unclips branchlines from the mainline, from the captain's position near the hauler, next to the fish door, and as a result, one of the coilers stands near the stern corner (N=8).

When there are gear tangles during hauling, the crew will move the branchlines to the stern where there is room to spread the branchlines apart in the water astern of the vessel, which can create a risk of catching seabirds. It is not feasible to untangle the branchlines in the water from the side of the vessel. (N=1).

Safety: There are no safety issues related to how far from the stern the crew doing branchline coiling stand (N=10).

Economic viability: If there was room to adjust crew position on deck when coiling and the new, more forward, position was practical, then it would not have an effect on economic viability (N=9).

Effective at avoiding seabirds during hauling: Reducing the distance behind the stern that the hooks come up during hauling could reduce the amount of time that birds can access them during hauling (N=9).

3.8. Vessel Speed during Hauling

Responses follow to questions related to having the captain adjust the vessel speed during hauling to enable crew to keep up with coiling branchlines, when seabirds are present.

What is your current vessel speed during hauling: It varies, because I alter the speed real time to match the speed that crew members are retrieving the gear and processing catch (N=1). About 5 to 6 knots (N=4). Between 6.8 and 7.0 knots, depending on conditions (N=1). 9-10 knots (N=2).

Practicality: It is practical (N=8). I already do this: I adjust the vessel speed during hauling in order to allow crew to keep up with processing catch and coiling branchlines (N=6). If too many branchlines pile up untended, they get badly tangled, so it is practical to adjust the vessel hauling speed to prevent this from occurring (N=6). I do not have to adjust the speed of the vessel during hauling to allow for crew to catch up with retrieving branchlines because there is a relatively large distance between two branchlines on the mainline, so that the crew have about 30 seconds in between each branchline that they haul (N=2).

Safety: It has no effect on safety risk (N=10).

Economic viability: It is economically viable (N=8).

Effective at avoiding seabirds during hauling: Not letting untended branchlines (lines temporarily unattended, clipped to the vessel rail or a lazy line) pile up is very likely useful for reducing bird captures during hauling (N=8). That's why I adjust the vessel speed during hauling to prevent too many branchlines from piling up, and why I do not use a lazy line (N=5). We never have a problem of a backlog of coiling branchines (N=2).

3.9. Water Jet

Responses follow to questions related to using a water pump to spray a jet of water over the area where baited hooks come to the surface during hauling.

Practicality: If the wind is coming from the stern, the water spray could get the crew wet (N=5). It could also get the deck wet (N=4). It would be practical to use, I do not foresee any problems with practicality (N=4). It would be easy to use existing equipment (hoses and pumps) for a spray system (N=1).

Safety: There are likely no safety issues (N=6). Having crew hit by the water spray and getting the deck wet might create a safety risk (N=4).

Economic viability: It would not have an effect on economic viability (N=10).

Effective at avoiding seabirds during hauling: It would work well (N=2). This is one method whose efficacy would not be affected by weather conditions (N=1). It might work alright (N=1.). If the water sprays lightly like a shower of water on the sea surface, it might increase bird captures because it might attract birds to the area by making the water surface look like a fish boil, but if the water is sprayed as more of a relatively high pressure jet then it might scare the birds from the area (N=6).

3.10. Haul Bycatch Mitigation Methods Captains Have Used

Below is a summary of seabird haul bycatch mitigation methods that captains indicated they have employed.

- Discarding offal and spent bait from the opposite side of the vessel from where they are hauling gear (N=7).
- Tori line (N=5). When I use a tori line, we deploy it so that it is not directly over the area where the hooks come to the surface, because during hauling when I need to stop the vessel, the aerial portion of the bird scaring line might drop down to touch the sea surface and come into contact with and entangle with the gear (N=5).
- Towed buoy (N=6). As with the tori line, we do not deploy it over the area where branchlines are coming to the surface, because when I need to stop the vessel during hauling, the line gets slack and drops to the sea surface, where it would potentially entangle with the gear if I deployed the towed buoy over the area where the baited hooks come to the surface.
- Bull horn. It worked the first time but the birds quickly habituated: after the birds returned to the vessel and I used the horn a second time, the birds did not get scared and fly away (N=1).

3.11. Other Methods Worth Considering

Below is a summary of additional seabird haul bycatch mitigation methods, including combinations of methods, not identified as alternatives in the survey, which captains identified as being worth considering.

- Have all available crew coil branchlines to ensure untended lines do not pile up (N=1).
- Use a tori line, with a small buoy at the end, and pieces of plastic and towels as streamers (N=1).
- Discard offal and spent bait from the opposite side of the vessel from where hauling is occurring (N=2).
- Towed buoy in combination with discarding spent bait or fish heads on the opposite side of the vessel from the hauling station (N=4).
- Towed buoy in combination with water jet spray (N=1).

3.12. Captain Preferred Method

Below is a summary of methods that the captains identified as their preferred choice to use to mitigate seabird bycatch during hauling if they were required to use a bird avoidance method

during hauls when seabirds were present. Some captains selected more than one method (hence the total number of responses is >10).

- Have the crew stand as far forward when coiling and coil as fast as possible (N=1).
- Tori line (N=5). Captains explained that they would select this method because they have used this in the past and are familiar with it.
- Bird curtain (N=5).
- Towed buoy (N=5). Captains explained that they would select this method because they have used this in the past and are familiar with it.
- Discard offal and spent bait from the opposite side of the vessel from where hauling is occurring (N=1).

4. RESULTS – DEMONSTRATION

The following sections paraphrase responses from the captain and observers on the practicality, economic viability, safety and efficacy of the bird curtain used during gear haulback.

4.1. Practicality

4.1.1. Was the bird curtain easy or difficult for crew to deploy and retrieve, and why?
It was easy to deploy and retrieve and took very little time to do both. Only during very heavy seas did it pose some difficultly for crew to deploy and retrieve. A crew member would climb onto the roof of the bait shack to deploy and retrieve the bird curtain (Fig. 2b). Two ropes, attached to the end of the bird curtain pole at one end, were tied to the railing of the bait shack roof on the other end to adjust the position and secure the curtain when deployed (Fig. 2c and d). The crew would untie these ropes from the railing to retrieve and store the curtain. The crew did not leave the bird curtain deployed during setting because the vessel makes a lot of sharp turns, which could result in the gear tangling with the curtain streamers.

4.1.2. Was the bird curtain easy or difficult to store on deck and why?
Stowage on deck was very simple and posed no issues. The crew would untie the ropes attached to the rail, swing the bird curtain pole parallel to the vessel stern and secure it to the rails (Fig. 2b), and retrieve and stow the streamers. The storage space for the curtain did not require changing conventional deck design or changing the location of other equipment or gear.

4.1.3. Did use of the bird curtain have a large effect on normal hauling activities? If yes, how?
During each trip, there were a small number (about three per trip) of incidences where hooks tangled with streamers while crew were retrieving and coiling branchlines. This occurred when the vessel made turns during gear retrieval. It was difficult to untangle the branchlines because it was difficult for crew to get onto the bait shack to access the bird curtain while gear haulback was in process. To attempt to resolve this, the captain on occasion would position the bird curtain at an angle off the starboard side (at about a 30 degree angle) instead of positioning the bird curtain directly perpendicular to the vessel stern.

Because the bird curtain seems to have reduced the incidence of bird captures, reducing the amount of time crew have to spend dealing with caught birds, the captain reported that he found using the curtain to make gear hauling more efficient.

4.2. Economic Viability

4.2.1. Did the bird curtain damage catch? If yes, how?
No, the bird curtain did not damage the catch. It had no effect on the condition of the catch.

4.2.2. Did the bird curtain cause catch to be more difficult to retrieve? If yes, how?
No, the bird curtain did not affect the ability of crew to retrieve catch.

4.2.3. Did the bird curtain damage the gear? If yes, how?
Discussed above, there were a few incidences when hooks snagged on the streamers, but this did not damage the gear.

4.2.4. Did the bird curtain affect the quantity or quality of the market catch? If yes, how?
No, the bird curtain had no effect on the catch – quality or quantity.

4.3. Safety

The bird curtain did not pose a risk to crew safety. Crew would climb onto the roof of the bait shack in order to deploy and retrieve the bird curtain. This was difficult only during very high swell. Crew routinely climb onto the roof of the bait shack in order to deploy and stow other gear (Fig. 2b, buoys stowed on roof of bait shack).

4.4. Efficacy

4.4.1 Effect bird access to baited hooks and the area where baited hooks come to the surface during gear haulback

The bird curtain appeared to result in the seabirds that were around the vessel to stay about 10 m astern of the vessel when the curtain was deployed during gear haulback (Fig. 2c and d), reducing their access to baited hooks and risk of capture. The captain and observers believed that there would have been several bird captures during gear haulback had they not used the bird curtain. Deployment of the bird curtain during hauling did not eliminate seabird attempts at removing bait from hooks during gear retrieval, but did seem to cause a large reduction in seabird attempts.

During one haulback, an observer briefly stowed the curtain to observe the change in seabird behavior. He noted that once he stowed the curtain, the seabirds moved into the area where baited hooks where coming to the surface and attempted to scavenge baits from hooks all the way to the vessel hull. When he redeployed the curtain, the birds moved back astern to about 10 m from the vessel stern. Thus, the absence and presence of the curtain appeared to affect seabird behavior.

4.5. Design

4.5.1. Did the bird curtain's streamers typically cover an area where hooks where at the surface during gear haulback? If not, where were baited hooks at the surface but not underneath the streamers?

The bird curtain streamers covered most of the area where baited hooks were at the surface during gear haulback. Hooks would come to the surface slightly astern of the area below the bird curtain streamers. The branchlines usually were retrieved underneath (and not adjacent to) the area covered by the streamers.

4.5.2. What changes in design did you make during the demonstration, and what additional changes would you recommend in order to improve the design of the bird curtain in order to improve efficacy at avoiding birds, make it more practical to use, avoid damaging the catch, and make it safer for crew to use?

The bird curtain was observed by the captain and observers to be practical to use. It had minimal interference with gear haulback operations, had no effect on the quality of the catch, and did not pose a risk to crew safety. The curtain appeared to work well at keeping seabirds out of the area where baited hooks come to the sea surface during gear retrieval.

Using a longer pole to protect an area further astern might improve the efficacy of the bird curtain.

The captain occasionally adjusted the angle of the curtain further starboard (instead of oriented directly astern), and after the first trip, he replaced garden hose with PVC as sleeve material at the bottom section of the streamers, and used two instead of three streamers. He made these design changes in order to attempt to reduce the risk of contact and entanglement between the streamers and the gear, and to reduce entanglement of the streamers with each other. It may be possible to come up with an improved material and/or design modifications for the sleeves in order to reduce the risk of hooks catching on the streamers. Reducing the length

of the streamers so that they just touch the sea surface in the absence of wind might also reduce the risk of hooks snagging on streamers.

In strong winds the three streamers used during the initial trip (Fig. 2c) frequently tangled. This did not appear to adversely affect the effectiveness of the bird curtain in keeping birds away from the vessel, however. Once the captain removed one of the streamers (Fig. 2d), the incidence of streamer tangling declined.

The durability of the bird curtain pole after longer-term use is a concern. The pole had a lot of swinging motion – moving horizontally about 2 m, which likely contributed to deterring birds from entering the area underneath and near the streamers. This movement, however, might eventually cause the pole to bend.

Adding reflective tape (such as the tape used on buoys) or other components might increase the deterrent effect on seabirds.

4.5.3. Factors affecting seabird capture risk during gear haulback

All three observers identified rate of branchline coiling by crew as an important factor affecting seabird catch risk during gear retrieval. One observer identified untended branchlines dragging astern as also being an important factor affecting seabird capture during haulback.

4.6. Future Use

The following is a summary of responses from the captain (and not the observers).

4.6.1. Are you likely to use the bird curtain after this demonstration project? How come?

The captain plans to continue to use the bird curtain after the completion of the demonstration project because he finds that it makes gear haulback more efficient by reducing bird captures and the time that his crew have to spend removing, handling and releasing caught seabirds during gear haulback.

4.6.2. Would you recommend that other vessel captains use a bird curtain during hauling?

The captain would recommend that over vessels also use a bird curtain during gear haulback.

5. CONCLUSIONS AND NEXT STEPS

Responses from interviews with captains of the Hawaii-based pelagic longline swordfish fishery suggested that a bird curtain and water jet device hold promise to effectively reduce seabird captures during gear haulback without creating issues related to practicality, safety or economically viability. There is no preexisting design for a water jet device for use during gear haulback, but it is likely feasible to produce a durable, simple device given adequate investment in research and development. A towed buoy and tori line were considered less promising as they might cause entanglements with the gear and prop.

Responses from the captain interviews, and feedback from the observers of the demonstration all identified crew branchline coiling rates as the most important factor affecting seabird catch risk during gear haulback. Captains and crew can readily correct slow coiling by an inattentive crew member. No practical options to achieve relatively fast coiling rates, however, were identified.

The observations made during a three-trip demonstration of a bird curtain suggest that the device holds promise at being both effective at avoiding bird captures during haulback and being commercially viable. Findings from the demonstration project were consistent with the responses from the captain interviews on the bird curtain. The bird curtain was practical to use, had minimal interference with gear haulback operations, had no effect on the quality of the catch, did not pose a risk to crew safety, and appears to work well at keeping seabirds out of the area where baited hooks come to the sea surface during gear retrieval. The captain's stated intention to continue to use the bird curtain following completion of the demonstration project suggests that his perceived benefits of using it outweigh costs. The captain found that the bird curtain made gear haulback more efficient by reducing bird captures and the concomitant time required for crew to remove, handle and release caught seabirds.

Differences in hauling practices and dimensions and deck layouts of individual vessels will dictate what length of bird curtain is needed to achieve similar bird mitigation efficacy. Because the gear retrieval methods used by the crew of F/V Quynh Vy result in a relatively small length of branchline dragging astern when crew are retrieving and coiling the branchlines, other vessels that have baited hooks coming to the surface further astern would require a bird curtain with a longer pole to protect an area further astern to obtain the same efficacy.

Assessments of alternative designs for bird curtains are needed to identify which dimensions and materials provide optimal durability, minimize risk of gear entanglement and maximize coverage of the area where baited hooks become available during gear haulback. Furthermore, assessments of the efficacy of alternative designs at mitigating captures during gear haulback across a range of environmental conditions (wind speed, wave height, illumination), seabird densities, seabird behavior would contribute to identifying a best practice bird curtain design for using during pelagic longline gear retrieval.

6. ACKNOWLEDGEMENTS

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Appendix 1

Questionnaire Form

Hawaii Longline Swordfish Vessel Captains' Input on the Commercial Viability of Alternative Methods to Reduce Seabird Bycatch during Gear Haulback

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Background

Seabird captures in the Hawaii longline shallow-set swordfish fishery have been reduced by about 90% through mitigating bycatch during setting. Now, about 75% of bird captures occur during hauling. About 50 Laysan and black-footed albatrosses are now caught during hauling each year in this fishery. A study conducted last year analyzed observer data and identified alternative methods to reduce seabird haul bycatch. Hawaii Pacific University with support from the National Marine Fisheries Service is seeking longline captain input on these alternative methods. Based on your input, we will trial the selected method during 3 trips to understand the method's commercial viability.

For more information
Eric Gilman, phone: 888-9440; email: EGilman@fisheriesresearchgroup.org

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Interview Questions

1. Today's date:

2. First and Last Name:

3. Position on vessel (e.g., captain, first mate):

4. Vessel name:

5. Date when last completed a shallow-set longline trip:

6. Number years participating in the Hawaii longline fishery:

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7. Below are 9 methods that might help reduce seabird captures during hauling. For each, what do you think of the practicality, safety, economic viability, and likely effectiveness at avoiding seabirds during hauling.

Considerations for practicality: Easy or difficult for crew to deploy, retrieve, and store on deck, and why. How will use of the method affect normal hauling activities?

Considerations for economic viability: Will the method damage catch, cause catch to be more difficult to retrieve, damage the gear, or affect the quantity or quality of market catch in any other way?

Considerations for safety: Will use of the method pose a risk to crew safety, and if yes, how?

(a) Deploy a bird curtain over the area where branchlines are retrieved when seabirds are present

Practicality:

Safety:

Economic viability:

Effective at avoiding seabirds during hauling:

(b) Tow a buoy in the area where branchlines are retrieved when seabirds are present

Practicality:

Safety:

Economic viability:

Effective at avoiding seabirds during hauling:

(c) Maximize crew branchline coiling rate when seabirds are present

How could crew increase their branchline coiling rate?

Practicality:

Safety:

Economic viability:

Effective at avoiding seabirds during hauling:

(d) Have crew refrain from flicking spent bait from hooks during hauling when seabirds are present

Practicality:

Safety:

Economic viability:

Effective at avoiding seabirds during hauling:

(e) Locate weighted swivels closer to the hook (branchline weights are placed an average of 6.6m from the hook)

Practicality:

Safety:

Economic viability:

Effective at avoiding seabirds during hauling:

(f) On vessels with a deck layout that permits adjusting crew positions during hauling, move position of crew coilers so that the distance between the crew position and the stern is ≥ branchline length (mean branchline length is 10.9m) (to avoid having baited hooks trail astern during coiling, so that baited hooks are protected from scavenging seabirds by the vessel hull)**.**

Practicality:

Safety:

Economic viability:

Effective at avoiding seabirds during hauling:

(g) Adjust the vessel speed during hauling to enable crew to keep up with coiling branchlines, when seabirds are present

Current vessel speed during hauling:

Practicality:

Safety:

Economic viability:

Effective at avoiding seabirds during hauling:

(h) Use a water pump and hose to spray water over the area where baited hooks come to the surface during hauling

Practicality:

Safety:

Economic viability:

Effective at avoiding seabirds during hauling:

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8. What methods have you used in the past, if any, to avoid birds during hauling?

9. Are there other methods, not discussed previously, that would be worth considering?

10. Are there combinations of methods worth considering?

11. What method would you pick to use, if you had to use a seabird avoidance method during hauls when seabirds were present?

12. Any other comments?

Appendix 2

NMFS Observer Comment Form: Seabird Haul Bycatch Mitigation Demonstration

Please provide completed form to: Eric Gilman, EGilman@utas.edu.au

Observer name:	Date start trip:
Number of hauls during the trip:	Date end trip:

1. **Method used as planned**
a. During how many of the hauls was the bird curtain deployed: _____

b. If not used during all the hauls, why do you think the captain and crew didn't use the method during all the hauls?

2. **Observations on practicality**
a. **Ease of deployment**: Was the bird curtain easy or difficult for crew to deploy and why:

b. **Ease of retrieval**: Was the bird curtain easy or difficult for crew to retrieve and why:

c. **Ease of storage**: Was the bird curtain easy or difficult to store on deck and why:

d. **Degree of effect on hauling operations**: Did use of the bird curtain have a large effect on normal hauling activities? If yes, how:

3. **Observations on economic viability**. Did the bird curtain:
a. **Damage catch** - if yes, how:

b. **Cause catch to be more difficult to retrieve** - if yes, how:

c. **Damage the gear** - - if yes, how:

d. **Affect the quantity or quality of market catch** - - if yes, how:

4. **Observations on safety**: Did use of the bird curtain pose a risk to crew safety? If yes, how?

5. **Qualitative observations on effectiveness at reducing bird captures**: Did the bird curtain appear to:
a. Have an effect on seabirds' ability to access the baited hooks?

b. Discourage birds from entering the area where baited hooks were coming to the surface during hauling?

6. **Provide your observations on the captain's and crew's opinions of the bird curtain, if they expressed their opinion to you or otherwise demonstrated their opinion in some manner**.

7. **What factors seemed to have a large effect on bird captures during hauling** (if there were seabird captures during hauling during this trip)? E.g., vessel speed during hauling, branchline spacing, crew rate of branchline coiling, untended branchlines dragging astern?

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8. **Design**

a. Did the bird curtain's streamers typically cover an area where hooks where at the surface during gear haulback? If not, where were baited hooks at the surface but not underneath the streamers?

b. Any suggestions on improving the design of the bird curtain, to improve efficacy at avoiding birds, making it more practical to use, avoiding damaging the catch, making it more safe for crew to use?

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9. **Other comments?**

Appendix 3

Hawaii Shallow-set Longline Vessel Captain Observations of Bird Curtain

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1. For each haul during the trip, did you use the bird curtain?
__ Yes
__ No If no, how come?

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2. **Observations on practicality**
a. **Ease of deployment**: Was the bird curtain easy or difficult for crew to deploy and why:

b. **Ease of retrieval**: Was the bird curtain easy or difficult for crew to retrieve and why:

c. **Ease of storage**: Was the bird curtain easy or difficult to store on deck and why:

d. **Degree of effect on hauling operations**: Did use of the bird curtain have a large effect on normal hauling activities? If yes, how:

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3. **Observations on economic viability**. Did the bird curtain:
a. **Damage catch** - if yes, how:

b. **Cause catch to be more difficult to retrieve** - if yes, how:

c. **Damage the gear** - - if yes, how:

d. **Affect the quantity or quality of market catch** - - if yes, how:

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4. **Observations on safety**: Did use of the bird curtain pose a risk to crew safety? If yes, how?

---

5. **Qualitative observations on effectiveness at reducing bird captures**: Did the bird curtain appear to:
a. Have an effect on seabirds' ability to access the baited hooks?

b. Discourage birds from entering the area where baited hooks were coming to the surface during hauling?

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6. **Design**
a. Did the bird curtain's streamers typically cover an area where hooks where at the surface during gear haulback? If not, where were baited hooks at the surface but not underneath the streamers?

b. Any suggestions on improving the design of the bird curtain, to improve efficacy at avoiding birds, making it more practical to use, avoiding damaging the catch, making it more safe for crew to use?

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7. Are you likely to use the bird curtain after this demonstration project? How come?

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8. Would you recommend that other vessel captains use a bird curtain during hauling?