# Field Evaluation of Seabird Deterrent Gear and Alternatives for Alaska Small Longline Vessels

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**U.S. Fish and Wildlife Service**
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## Executive Summary

Where seabirds are present, commercial longline vessels in Alaska have the potential to catch seabirds in their gear, in particular, species of special concern such as the endangered short-tailed albatross. As a result, the National Marine Fisheries Service (NMFS) in conjunction with the United States Fish and Wildlife Service (USFWS) developed regulations requiring commercial fishermen to deploy bird deterrent devices while fishing.

In 2003 and 2004, the Alaska Sea Grant Marine Advisory Program undertook a collaborative demonstration project, with funds provided by the USFWS, to develop practical ways of reducing bird interactions with longline gear deployed by small vessels. We relied upon the cooperation and ingenuity of small vessel owners to accomplish this goal. We did not evaluate the novel methods for effectiveness in deterring seabirds; rather, we examined the logistical and economic practicalities of using the new methods. Six projects were undertaken with halibut longline vessels from ports ranging from Southeast Alaska to Kodiak.

One project involved construction and **testing of a custom-made davit** that allowed a small sternpicker vessel to fly the required streamer lines with less risk of fouling the streamer line on the sinking groundline. The davit and adapted streamer line were tested against the NMFS published performance standard for 32 ft LOA vessels setting snap gear, which requires that the streamer remain aloft for 65.6 ft (20 m) behind the vessel and within 6.6 ft (2 m) horizontally of the point where the main groundline enters the water. Streamer line performance standards for this vessel type can be met using this device and a lightweight streamer line.

Two projects tested the ability of variously **weighted groundlline** to increase the sink rate of baited gear and thus reduce gear exposure to seabirds. Sink rate was measured against an international standard target rate of 0.3 m/s. Heavier, 3/8-in leaded Manline and standard 11/3-in, 5/16-in, and 1/4-in unleaded groundline were tested on a twin jet bowpicker side-setting conventional gear, a single outdrive bowpicker setting and retrieving gear over the bow with snap-on gear , and a single-prop sternpicker setting and retrieving snap-on gear over the stern. Sink rates ranged from 0.08 to 0.2 m/s and did not reach the international standard.

In a related project, nine 5-lb snap–on weights and two 8-lb junction weights were added to the 3/8-in leaded Manline, and a sink rate of 0.26 m/s was achieved. While this configuration approached the international target sink rate, the gear was found to be impractical. Using 56 lbs or 11 weights per skate would require a vessel to carry upwards of 1,000 additional pounds if 10 skates were being deployed. For smaller vessels, this amount would have a considerably negative impact on deck safety, boat handling, and stowage requirements.

Methods for improving the practicality of two types of deterrent gear currently required by regulation were evaluated in two additional projects. The first involved **covering the**

**drag line** on buoys deployed as bird deterrents behind vessels with various diameters and types of discharge hoses to decrease the chance of the drag line fouling on the circle hooks. Two types of hose were tested, and both were found to decrease the likelihood of fouling because the hose-covered drag line was wider than the hook opening. The second project addressed the difficulty smaller vessels have in achieving recommended performance standards with **streamer lines** distributed for free by USFWS at that time. A lighter-weight line was constructed and tested on a 37 ft LOA sternpicker with overhead rigging. As with all of our projects, we did not evaluate effectiveness in reducing seabird interactions, but in winds less than 15 knots, light seas, and setting speeds of 2.8 to 3.2 knots, this line reached the performance standard.

Another project examined the idea that, when longline gear is **set off the side of the vessel,** the vessel itself acts as a deterrent to birds attacking the bait. The project applicant had observed that flying seabirds avoid approaching too close to a vessel, and proposed that a boat "shadow" existed in which seabirds would avoid attacking bait. Using sink rate measurements and a measurement buoy, it was determined that, in most cases, the average distance of the groundline sinking to a desired depth of 2 m was well beyond the theoretical "shadow" of the boat.

A final project evaluated converting a **net washdown** system commonly used on gillnetters to create a stream of water that would fall over the sinking groundline and deter bird attacks. Such a system was created on a 34 ft LOA bowpicker using a three-inch Pacer pump. Cloudiness of the spray was recorded with still photographs. A slight breeze was observed to blow the spray off the setting gear. In calm conditions, the total length of the area covered by spray fore of the vessel ranged from 1-15 m and the spray fell to the water 30 m fore of the vessel, which was moving in reverse.

Conclusions and recommendations

In consultation with project skippers and an advisory committee of industry members and researchers, we conclude:

- No seabirds were seen actively pursuing baited hooks during any of our studies;
- heavier streamer lines distributed by Pacific States Marine Fisheries Commission for USFWS are too heavy to be used effectively on many small longline vessels, but lighter-weight streamer lines can achieve the required performance standards;
- construction and use of a davit may allow some smaller vessels to deploy streamer lines away from their gear and thus reduce the chances of fouling;
- reaching desired groundline sink rates by using heavier groundline or by adding additional weight is a serious challenge for a small vessel and international standards for sink rates were not met under test conditions;
- covering buoy drag lines with pliable hose can decrease fouling of buoy lines with halibut gear;
- side-setting conventional gear from a small bowpicker does not appear to significantly reduce the distance behind the stern that gear sinks to a 2 m depth; and

- a 3-in Pacer pump can be adapted to create a 1.5 m wide by 12-15 m long area of spray on the water at a maximum distance of 30 m behind a vessel. However, light winds can blow this spray off the center plane in which the gear would be sinking.

Recommendations as a result of this project are: 1) consideration be given to testing seabird deterrence of lighter-weight streamer lines, 2) if found effective, lighter-weight streamer lines be constructed and distributed for free to small boat operators, 3) research on the use of integrated weight groundline on smaller vessels be continued, particularly on the 40 - 50 ft LOA vessel class, and 4) outreach efforts be undertaken to inform smaller vessel owner/operators about buoy line covering, davit designs and associated costs.

Epilogue: Since the completion of this work, an additional project funded by USFWS was undertaken to create and distribute free lighter weight streamer lines. Details of this work will be published at www.marineadvisory.org.

## Introduction

Where seabirds are present, commercial longline vessels in Alaska have the potential to catch seabirds in their gear, in particular, species of special concern such as the endangered short-tailed albatross. As a result, the National Marine Fisheries Service (NMFS), in conjunction with the United States Fish and Wildlife Service (USFWS) developed regulations requiring commercial longline fishermen to deploy bird deterrent devices while fishing.

Currently, larger longline vessels (greater than 55 ft LOA) fishing in Alaska waters are required to use paired streamer lines (called "tori lines") flown over the groundline when setting gear. Depending on vessel size, overhead rigging configuration, and setting style, smaller vessels use either a single streamer line flown aloft or a buoyed drag line extended from the vessel over the sinking groundline.

The Alaska Sea Grant Marine Advisory Program's (MAP) seabird deterrent project coordinated the expenditure of funds provided by the USFWS to support efforts by small vessel owners and operators to develop additional or alternative techniques to avoid seabird interactions with longline gear appropriate to this vessel class. We solicited their ideas for adapting existing methods or developing new methods, and then observed and tested these methods for compliance with regulated performance standards and practicality. None of the project ideas were tested for actual seabird deterrence effectiveness; recommendations were made as to which methods might merit further evaluation with seabirds present.

## Overall Project Design

In July 2003, the Alaska Sea Grant Marine Advisory Program, in cooperation with Cordova District Fishermen United (CDFU), made small grants available to Alaska commercial longline fishermen with vessels less than 55 ft LOA interested in 1) testing gear and ideas on how to better comply with existing federal regulations for seabird by-catch avoidance for vessels in this class, and 2) documenting alternative methods and gear for small vessels to better comply with the intent of these regulations. The goal of this project was to solicit ideas from fishermen and, after preliminary tests, recommend further testing of those ideas which showed the most promise as being both workable for fishermen and effective at deterring seabird/fishing gear interaction.

With the assistance of an industry/science advisory group (see Acknowledgements for a list of advisory group members), the MAP co-coordinators developed a project scope and advertised the solicitation through industry list serves, websites, newspapers, and public service announcements statewide. Project ideas were received from small vessel fishermen from Kodiak, Homer, Anchorage, Cordova, Petersburg, and Sitka. Cordova District Fishermen United's Groundfish Division submitted four project ideas as a coordinated effort among their members. Based on the advisory group's recommendations, all project ideas were accepted for funding. Six projects were completed during the summers of 2003 and 2004.

## Project 1: Telescoping Boom with Roll-up

The first project demonstrated an alternative method for using streamer lines on vessels with no mast or a center mast with no boom.  Peter Thompson, captain of the F/V *Dues Payer II* proposed to solve this problem by building a device to be mounted on the aft port or starboard side of the vessel that would rotate on its vertical axis, telescope to vary the length of the boom, and contain a coiler housing to wind the streamer line in and out.

The *F/V Dues Payer II* is a 32 ft LOA sternpicker rigged for snap gear.  The gear is deployed from amidships from an hydraulic reel, through a series of blocks, and finally through a pigtail mounted at the stern on the center line of the vessel.  The *F/V Dues Payer II* has a single mast with no boom that is also located on the center line of the vessel.  Deploying a streamer line from this mast would likely cause the streamer to foul on the groundline because both would leave the vessel and enter the water in the same plane.  Thompson proposed deploying the streamer line from the far port side of the vessel to avoid fouling.

Gear design/description

Thompson commissioned E. Norton Incorporated to fabricate the boom from aluminum. The device is mounted to the vessel using two C-clamps attached through holes drilled into the rail.  The boom consists of a vertical pole and an arm welded at approximately 45 degrees from horizontal.  The arm is made from two aluminum tubes, the upper of slightly smaller diameter than the lower.  The upper tube can slide into or out of the lower to extend or shorten the length of the arm (Figure 1). The vertical pole is mounted on two discs.  Holes were drilled through both discs in several locations.  The entire device can be rotated and then locked into place by aligning an upper hole with one of the lower ones and inserting a pin, which is attached to the device with a short line (Figure 2). Mounted at the base end of the telescoping arm is a spool with a handle on it for storing, deploying and retrieving the streamer line.  A guide piece is welded to the top end of the telescoping arm to conduct the streamer line.  Finally, a small cleat is mounted about one foot above the reel to allow the line to be tied off at varying lengths.

*Figure 1: Streamer line davit built by E. Norton, Inc.*

*Figure 2: Davit swivel mechanism.*

Preliminary testing

Thompson originally loaded the reel with 1/4-in yellow poly triple-braid line. Five-foot long strips of orange and chartreuse surveyors tape were threaded through the braids at one-foot intervals to act as streamers. A solid plastic gillnet cork was attached to the end of the poly line to create drag. Preliminary testing of the device aimed to ensure that the aluminum device was strong enough to withstand the drag created by the line, to determine the ease or difficulty of deployment using the device, and to pilot the device to find any problems before official testing began.

Thompson tested the device on a trip to the Albatross Banks south of Kodiak Island. He found that the device functioned as it was designed to, and, aside from a few problems noted below, was convenient and easy to deploy. The streamer line is stored on the reel, away from any other gear and not underfoot. The pivoting ability of the device allowed Thompson to adjust the distance from the point the groundline entered the water to the streamer line. The cleat mounted to the arm allowed him to easily adjust the amount of streamer line being deployed.

Skipper Feedback

Thompson identified three areas of concern in preliminary testing, all dealing with the construction of the streamer line itself, not the deploying device.

1. Thompson originally threaded the streamers onto the main line starting at the far end of the line. Thus, when the line was not in use, those streamers were still exposed to the rain and wind. Occasionally, a few wet streamers would wrap around the boom and stick to it. When he subsequently tried to deploy the line, Thompson was forced to spend additional time unwrapping the streamers from the pole. Thompson felt that leaving the first few feet of line free of streamers would prevent this problem.

2. The streamers would also occasionally become tangled on the reel because of the main line wrapping over the streamers as it was reeled in. This could be lessened by guiding the line next to the boom by hand as it was wound onto the reel. The streamers were then straightened out as they ran through the "guide" created by the fingers.

3. While Thompson did not experiment to try to meet the proposed performance standards for distance aloft, it appeared the line was entering the water less than the proposed 20 m behind the vessel. We discussed using a different type of line as the main streamer line as well as alternative methods for creating drag.

Methods and Results for Project 1

Before beginning testing to determine if the proposed performance guidelines for small boats could be met using this device, we removed the flagging from the first few feet of the streamer line. In addition, in an attempt to create more drag, a 5-in diameter plastic funnel was strung onto the line above the buoy. A three inch piece of 3/4-in heater hose was added to the narrow end of the funnel to smooth the transition from funnel to rope and prevent it from snagging. In addition, electrical tape was used to smooth the transition from tube to rope (Figure 3).

*Figure 3: Funnel and buoy used to create drag on streamer line.*

Testing was conducted on September 26, 2003, in 2-4 ft seas and winds about 10 knots. Unless otherwise noted, all test sets were made with the wind. In all sets, the streamer line was deployed shortly after the anchor was dropped and was retrieved shortly before the end of the skate was deployed.

**Table 1: *F/V Dues Payer II* Streamer Line Performance - Setting Gear with Wind**

| Setting speed (knots) | Line deployed (ft) | Line aloft min/max (ft) | Height (pole tip to water) | *Met standards |
|---|---|---|---|---|
| 4.7 | 125 | 50/60 | 10 ft | |
| 4.7 | 150 | 60/80 | 10 ft | * |
| 5.2 | 100 | 50/60 | 12 ft | |
| 5.2 | 200 | 100/125 | 12 ft | * |
| 4.4 | 200 | 90/110 | 12 ft | * |
| 3.5 | 200 | 75/100 | 12 ft | * |
| 4.4 | 125 | 50/60 | 12 ft | |
| 5.5 | 125 | 70/75 | 12 ft | * |
| 5.8 | 100 | 60/75 | 12 ft | * |

For the last set we switched the main streamer line from 1/4-in yellow poly triple-braid line to #84 tarred nylon seine twine.

While the gear was soaking, we deployed this new line several more times, without setting additional gear.

**Table 2: *F/V Dues Payer II* Streamer Line Performance - without Setting Gear, with Wind**

| Setting speed (knots) | Line deployed (ft) | Line aloft min/max (ft) | Height (pole tip to water) | *Met standards |
|---:|---:|---:|---:|---:|
| 5.5 | 125 | 75/80 | 12 ft | * |
| 5.6 | 150 | 60/80 | 12 ft | * |
| 5.6 | 175 | 75/90 | 12 ft | * |
| 5.6 | 200 | 100/120 | 12 ft | * |
| 4 | 200 | 60/100 | 12 ft | * |
| 5 | 100 | 60/80 | 12 ft | * |

On the sixth deployment, we removed the cork from the drag set-up, but still used the funnel. With this rigging, the end of the streamer bounced on the waves a bit more.

Finally, we deployed the line while we were motoring into, rather than with, the wind.

**Table 3: *F/V Dues Payer II* Streamer Line Performance - without Setting Gear, Moving into Wind**

| Setting speed (knots) | Line deployed (ft) | Line aloft min/max (ft) | Height (pole tip to water) | *Met standards |
|---:|---:|---:|---:|---:|
| 4.6 | 125 | 75/100 | 12 ft | * |
| 4.5 | 150 | 75/90 | 12 ft | * |
| 5 | 200 | 100/120 | 12 ft | * |

In all sets, we were able to keep the streamer line within 6 ft horizontally from where the groundline entered the water when the vessel was moving straight forward. When the vessel turned to port, the streamer line approached the groundline more closely. At one point, the streamer line crossed over the groundline. This crossover was very worrisome for Thompson, who immediately retrieved the streamer line. Although the streamer crossed directly over the groundline, it did not hang up as he reeled it in. Thompson then deployed the streamer line again. On a subsequent set, when he knew that he was about to make a hard turn to port, Thompson adjusted the angle of the device further from the groundline to prevent this crossover. When the vessel turned to starboard, the streamer line moved further away from the groundline to an estimated maximum of 12 ft. As the vessel straightened from the turn, the streamer drifted back to within 6 ft.

Approximately 880 hooks were deployed in the first set, 770 hooks in the second live set, and 550 hooks in the third live set. No birds were hooked on any of these sets. One fulmar landed on the water near the deploying groundline, but did not follow the gear as the boat moved forward. Several other fulmars and gulls flew over the gear as it was setting, but did not dive or land. No other birds were observed during gear deployment. Groups of fulmars and other gulls congregated on the water around the vessel as the gear was being retrieved and catch was being cleaned.

Discussion

The use of this device allows a smaller vessel with a center mast to deploy streamer lines while lessening the chance of hanging the line on the gear. Recommended performance guidelines for distance aloft can be met using this device. The streamers on the test line did not meet the construction standards for streamer lines, however. The heavy streamer lines presently distributed by the National Marine Fisheries Service meeting these construction standards are too heavy to be used with this device. Thompson expressed interest in experimenting with materials other than surveyors tape for streamers. Quarter-inch yellow poly line or tuna leader may provide better “action” on the streamers and coil better on the reel.

We made no attempts to test the effectiveness of the streamer lines on deterring bird attacks, other than observing the behavior of birds in the test area. Additional information on bird interactions with alternative streamer construction could be used to create recommended methods and materials for lighter-weight streamers.

## Project 2: Integrated Weighted Groundline Sink Rate

In this project, a group of fishermen belonging to CDFU proposed to compare the sink rates of a readily available weighted groundline (3/8 in leaded Manline, 75 lbs per skate) with their existing gear in a variety of configurations (snap-on and conventional gear with bow, stern, and side setting configurations). In 2002, Ed Melvin of Washington Sea Grant tested sink rates of various unbaited groundline gear used by the Cordova small vessel fleet, and the group was motivated to continue this type of investigation.

In the Prince William Sound area, most small boats (gillnet bowpickers and sternpickers less than 32 ft LOA) deploy groundline on and off an hydraulic reel. Baited hooks and gangions are individually attached (snapped) onto the groundline as the line is being set (hence the term “snap gear”). On the other hand, salmon seiners (43 - 55 ft LOA) and a small percentage of larger bowpickers (30 – 32 ft LOA) use conventional (also “fixed” or “stuck”) gear, in which gangions with hooks are permanently affixed to the ground line. In this case, lengths or “skates” of conventional ground line are stored in individual tubs on deck. The groundline is deployed directly from the tubs and retrieved back into tubs with the aid of a hydraulic line puller. No seine boats were used in the CDFU testing, but one conventionally rigged bowpicker, the F/V *Cape Fear*, was included.

### Groundline Sink Rate Testing Methods

For the weighted groundline tests, an international standard bottle test protocol was used. Plastic bottles on 2-m tethers are clipped onto the groundline at various intervals as the groundline is being deployed. In general, to obtain a statistically significant sample, 7 to 10 bottles per skate is desirable. An onboard observer records the length of time from when the bottle clip enters the water to when the bottle flips vertically, indicating the groundline has reached a depth of 2 m. Melvin explained that bottle flip times of between 6.5 to 7 seconds indicate the desired sink rate of 0.3 m/s.

With guidance provided by Melvin, we modified 60 750-ml plastic water bottles for testing purposes. Each bottle was fitted at the bottle neck with a 2-m string and a halibut snap looped onto the other end. An orange landscape flag was added to the body of the bottle to help the observer more easily determine, once the flag flipped up, when the groundline reached the 2-m depth.

*Figure 4: Plastic water bottle, flagging, and 2-m line with snap.*

<u>Types of Vessels Tested</u>

With the cooperation of CDFU fishermen available in August with halibut quota, we were able to test gear on three types of vessels:

1) a twin jet bowpicker sidesetting and retrieving conventional gear (F/V *Cape Fear)*;
2) a single outdrive bowpicker setting and retrieving gear over the bow with snap-on gear (F/V *Salmo)*;
3) and a single prop sternpicker setting and retrieving over the stern with snap-on gear (F/V *Gretchen S.)*.

<u>Project 2 – F/V *Cape Fear*</u>

The F/V *Cape Fear* is a 32 ft LOA twin jet bowpicker. Captain Rob Eckley and one crewmember use conventional gear. The groundline is deployed and retrieved from amidships off the port side of the vessel ("sidesetting"). The gear is set with the vessel running forward. As with most bowpickers, there is no overhead rigging. The vessel utilizes a buoy drag line to comply with current seabird deterrence regulations.

In preparation for this comparative test, the crew built two skates (1800 ft each) of 3/8-in test gear with 100 hooks per skate on 53-in gangions. The *Cape Fear's* halibut gear is 11/32-in unleaded groundline with approximately 66 hooks per 1200-ft skate. After baiting with squid, the test gear skates weighed 79 lbs, and the F/V *Cape Fear's* shorter skates weighed 68 lbs. Eckley's groundline is the older soft lay gold line used primarily for the easier sea conditions found during summer fishing in the Sound.

Two skates of the F/V *Cape Fear's* gear were deployed followed by two skates of the test gear. An anchor and line were dropped, and the gear was hauled back beginning at the opposite end. Conditions were foggy, calm, and no swell.

<u>Results F/V *Cape Fear*</u>

In general, this data set averaged 5 data points per skate, with 7 bottles deployed per skate. We quickly discovered attaching bottles to tub gear was dangerous even at slower setting speeds. Therefore we pre-attached test bottles to the skates by randomly digging down into the side of the tubs and attaching the bottles. The spacing of the bottles was uneven. With only one timer on deck, some sink rate times were missed due to two unflipped bottles floating in the water at once. When he could, the skipper backed up the timer with a second watch.

*Figure 5: Numbered and attached bottles placed for deployment atop conventional gear. F/V Cape Fear*

At a setting speed of 3.95 knots, sink rates were as follows:

**Table 4: *F/V Cape Fear* Comparative Groundline Sink Rates**

| Gear | Average time (s) from point of water entry to 2 meter depth | Number of bottles deployed | Average sink rate m/sec. |
|---|---|---|---|
| Skate 1: 11/32-in Gold line | 19.61 | 6 | 0.10 |
| Skate 2: 11/32-in Gold line | 9.88 | 5 | 0.20 |
| Skate 3: 3/8-in weighted test gear | 10.36 | 3 | 0.19 |
| Skate 4: 3/8-in weighted test gear | 15.53 | 6 | 0.13 |

Neither gear reached the desired sink rate of 0.3 m/s. The groundline entered the water 6 - 10 ft aft of amidships and 2 ft before the stern of the vessel. At this setting speed we visually estimated the groundline reached the 2-meter depth about 90 ft behind the boat.

The crew reported the heavier groundline was not too difficult to handle in tubs. Eckley is very interested in trying the heavier gear used in Melvin's 2002 Dutch Harbor work.

<u>Project 2 – F/V *Salmo*</u>

The F/V *Salmo* is a 30 ft LOA single outdrive bowpicker.  Captain Curt Herschleb and one crewmember use snap-on gear and deploy the groundline through a roller over the bow of the vessel. The gear is set with the vessel running in reverse. The gear is retrieved directly back over the bow with an hydraulic reel. As with most bowpickers, there is no overhead rigging and deck space is limited. The vessel utilizes a buoy drag line to comply with seabird deterrence regulations.

In preparation for this comparative test, the crew added two skates (1800 ft each) of 3/-in test gear to the vessel's reel. The aim of this initial deployment of snap-on gear was to attach 7 to 10 bottles per skate, and to compare the sink rates of the test gear with the vessel's unweighted 5/16-in gear.  The vessel's gear weighs 53 lbs per skate unbaited. The test gear weighs 75 lbs per skate unbaited.

*Figure 6: Adding test gear to hydraulic reel. F/V Salmo*

<u>Results F/V *Salmo*</u>
Two skates of the F/V *Salmo's* gear were deployed followed by two skates of the test gear. An anchor and line were dropped, and the gear was hauled back beginning at the opposite end. Conditions were foggy, calm, and no swell.

To get the required 7 to 10 data points per skate, it became obvious that, for snap-on gear, the groundline needed to be pre-marked. This is something we remedied in subsequent tests, but this was not done for the F/V *Salmo* tests.

At a setting speed of 2.8 knots, the sink rates were as follows:

**Table 5: *F/V Salmo* Comparative Groundline Sink Rates**

| Gear | Average time (s) from point of water entry to 2 meter depth | Number of bottles deployed | Average sink rate m/sec. |
|---|---|---|---|
| Skate 1: 5/16-in line | 21.15 | 5 | 0.09 |
| Skate 2: 5/16-in line | 19.03 | 5 | 0.11 |
| Skate 3: 3/8-in weighted test gear | 23.38 | 6 | 0.09 |
| Skate 4: 3/8-in weighted test gear | 25.74 | 6 | 0.08 |

While this dataset is inconclusive due to a lack of a sufficient number of data points, in general neither gear reached the desired sink rate of 0.3 m/s. The groundline entered the water 6 - 10 ft from the bow. It was estimated the groundline reached the 2-meter depth approximately 60 ft behind the boat. It was noted for these weights of standard gear, there was no significant difference in sink rate between weighted and unweighted gear under these slow setting circumstances.

<u>Project 2 – F/V *Gretchen S*</u>

The F/V *Gretchen S* is a 37 ft LOA single screw sternpicker. Captain Dan Hull and one crewmember use snap-on gear and deploy the groundline through a roller over the stern of the vessel. The gear is set off an hydraulic reel and retrieved back onto the reel from amidships through an hydraulic line hauler. The gear is set with the vessel running in forward. The vessel has overhead rigging and uses a streamer line to comply with seabird deterrence regulations.

In preparation for comparative tests, the crew built 400 gangions/snap/hooks for four skates of test gear. The vessel's halibut gear is 5/16-in leaded line with approximately 80 hooks per 1800 ft skate. The 5/16-in gear weighs 56 lbs per skate unbaited. All gear had been pre-marked to minimize missed bottle attachment and to maximize the number of bottle data available from each skate.

<u>Results F/V *Gretchen S*</u>

The setting order for this series of tests was similar to F/V *Cape Fear* and the F/V *Salmo.* The crew loaded the F/V *Gretchen S's* gear and the test gear onto the reel with the testing sequence in mind. We chose to deploy three skates of each gear, and to set the vessel's gear and the test gear separately whenever possible to equalize all test conditions.

The following setting order was run: anchor and buoy dropped, three skates of 3/8-in test gear deployed, and another anchor and buoy dropped. Within two miles of the first set, a second anchor and buoy were dropped, three skates of 5/16-in gear deployed, and another anchor and buoy dropped. Finally, for the third set, the remainder of Hull's gear was deployed.

The vessel's setting speed for Test A was 3.1 knots and for Test B 2.6 knots with the following results:

**Table 6: *F/V Gretchen S* Comparative Groundline Sink Rates**

| Gear | Average time (s) from point of water entry to 2 meter depth | Number of bottles deployed | Average sink rate m/s |
|---|---|---|---|
| Test 1A: 3 skates test gear | 14.76 | 21 | 0.14 |
| Test 1B: 3 skates 5/16-in leaded gear | 17.68 | 22 | 0.11 |

Neither gear reached the desired sink rate of 0.3 m/s.

Project 2 testing was done in conjunction with Project 3. Discussion of the results for both projects is found at the end of Project 3.

## Project 3 – Additionally Weighted Groundline Sink Rate

The goal of this project was to test the practicality of additionally weighting the test gear. We used the weighted groundline and test gear aboard the F/V *Gretchen S* described in Project 2.

Questions to be explored with this project from the advisory committee and from participating fishermen were more logistical in nature: How much weight needs to be added to get within the desired sink rates? How many weights need to be available to the crew if setting 5 to 12 skates? Will there be interference with operations with limited deck space?

To answer these questions, we choose to add additional weight by deploying the four skates of test gear with Hull's usual eight-pound junction weights and adding two five-pound weights; each one at the quarter and three-quarter skate marks. This pattern increased the total weight of the skate by 25%; the 5/16-in skate weight (minus baited snaps) increased by an additional 28 lbs (including snaps) for a total of 84 lbs. In all tests conditions were calm.

Vessel setting speed was 2.5 knots with the following results.

**Table 7: *F/V Gretchen S* Added Weight Groundline Sink Rates: Test 1C**

| Gear | Average time (s) from point of water entry to 2 meter depth | Number of bottles deployed | Average sink rate m/s |
|---|---|---|---|
| Test 1C: 1+ skate 5/16-in leaded gear + 28 lbs | 16.80 | 10 | 0.12 |

Vessel setting speed was 2.8 knots with the following results.

**Table 8: *F/V Gretchen S* Added Weight Groundline Sink Rates: Test 2A**

| Gear | Average time (s) from point of water entry to 2 meter depth | Number of bottles deployed | Average sink rate m/s |
|---|---|---|---|
| Test 2A: 3/8-in weighted test gear plus 28 lbs | 9.73 s | 23 | 0.21 |

Since Test 2A results were the closest of any of the testing to the desired sink rate of 0.3 meter/second, and with good weather and a small amount of fish quota still remaining, we decided to fish and test the gear for an additional day.

At a setting speed ranging from 2.8 to 3.1 knots (2.9 average), in calm seas, wind at 5 knots, the following results were obtained:

**Table 9: *F/V Gretchen S* Added Weight Groundline Sink Rates: Test 3A**

| Gear | Average time (s) from point of water entry to 2 meter depth | Number of bottles deployed | Average sink rate (m/s) |
|---|---|---|---|
| Test 3A: 3/8-in test gear plus 2 junction weights (16 lbs.) plus 9 snap-on weights (5 lbs ea.) | 7.74 | 19 | 0.26 |

Discussion of Project 2 and 3:
None of the gear configurations tested reached the desired sink rate of 0.3 m/s. Using 56 lbs or 11 weights per skate would require a vessel to carry upwards of 1,000 additional pounds if ten skates were being deployed. For smaller vessels, this amount would have a considerably negative impact on deck safety, handling, and stowage requirements.

## **Project 4: Improving Current Deterrent Gear: Protected Buoy Line and Lighter Weight Streamer Lines**

The CDFU group wanted to test two ideas for improving the practicality of using current seabird deterrent gear required for their respective vessels.

The opening on circle hooks commonly used for halibut fishing is 1 inch. Bill Lindow, captain of the F/V *Jitterbug*, wanted to explore his idea of covering the buoy drag line with various diameters and types of discharge hose to decrease snagging with his gear. Three vessels, F/V *Jitterbug*, F/V *Salmo*, and the F/V *Cape Clear* tested Lindow's idea.

Dan Hull, captain of the F/V *Gretchen S*, wanted to see if a lighter weight version of the current streamer line available for free from USFWS for larger vessels could reach the regulatory performance objective for smaller vessels. His vessel was the only CDFU boat with overhead rigging and using a streamer line for compliance.

### Results from Project 4: Protected Buoy Line

The F/V *Jitterbug* is a 30 ft LOA bowpicker with no overhead rigging that is rigged for fishing snap-on gear . Under current regulations, the vessel is required to drag a buoy line as a seabird deterrent. The longline gear is deployed over the bow off an hydraulic reel and retrieved over the bow onto the reel. The two size hoses selected for the project were 1-1/8-in hard lay discharge hose (brand name: "Trident") and softer lay 1-in bilge hose (brand name: "Rule").

Lindow and his crewmember attached a number "0" buoy to the trailing end of the deterrent line. In order to minimize snagging the groundline at the buoy/line juncture, Lindow added a wide mouthed plastic funnel to cover the knot at the buoy. Two shots of buoy line were threaded through the two hose types, and the hoses were secured to the lines in much the same way chafing gear is fixed to an anchor line.

*Figure 7: 1" Trident hose, number "0" buoy, and plastic funnel knot protector. F/V Jitterbug*

The F/V *Jitterbug* spent two days of a multiple-day halibut trip testing the prototype gear. No observer was available for the trip. Lindow was provided a digital still camera to document the testing, and he submitted a written report and debriefed with the co-coordinator at the conclusion of the testing. The following are comments compiled from his written report.

Test 1: 8/7/03
Hose: 1 1/8-in Rule-type discharge hose
Conditions: Foggy. Wind 5-10 knots, no swell, less than 1ft chop
Setting speed: 2.5 knots
Rigging: The bird buoy was a red size "0" inflatable. The buoy line was 5/16-in groundline passed through a 5 to 6-in diameter plastic funnel at the buoy end, then through the hose (50 ft). The funnel covers the knot at the buoy.

*Effectiveness*
The 1 1/8-in hose was 100% effective at preventing tangling of buoy line with the hooks (#16) while setting. There were numerous crossovers of groundline and the buoy line/hose with no catching.

*Comments*
The 50 ft length of hose plus an extra 10 ft of buoy line at the boat end placed the bird buoy at the appropriate area where the groundline entered the water. Only one seabird was observed [in the area], with no interaction with the gear. Deployment and stowage of the bird avoidance gear was quite easy, but it does occupy more storage space on deck. Threading the buoy line through the hose proved difficult onboard. We used an end wrench tied to the line as a weight to help get the line threaded through the hose. Threading would be easier in port where one can get up higher and use gravity. An alternative might be to use compressed air to push a plug with string attached through the hose.

It is possible the use of hose provides additional seabird deterrence because of its bigger size and higher visibility than the 5/16-in buoy line alone.

*Figure 8: Deploying Rule hose buoy line over portside amidships. F/V Jitterbug.*

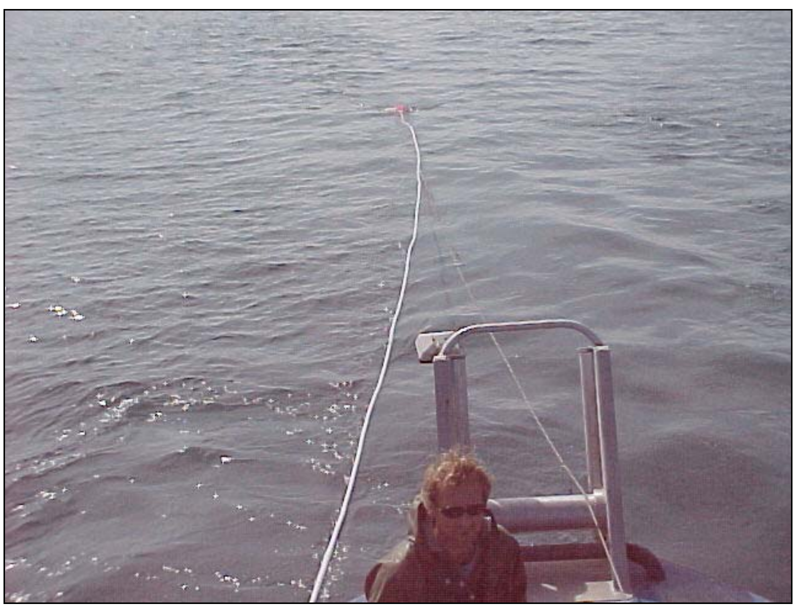

*Figure 9: Deployed Rule buoy drag line with groundline over bow. F/V Jitterbug*

Test 2: 8/8/03
Hose: 1-in Trident discharge hose
Conditions: Clear. Wind less than 5 knots, no swell, no chop
Setting speed: 2.5 knots
Rigging: The bird buoy was a red size “0” inflatable. We were unable to thread the 5/16-in buoy line through the smaller hose. We drilled holes through the sides of the hose at each end and used gangions to tie the hose to the buoy and the boat. The plastic funnel was used as before.

*Effectiveness*
The outside diameter of this hose is only slightly less than the 1 1/8-in Rule hose. It was just as effective as the 1 1/8-in Rule hose except that one hook caught on the knot where the buoy was tied to the hose with the gangion.

*Comments*
The 1-in Trident hose is slightly heavier and stiffer, making it just a little harder to store and deploy than the Rule hose, however, it will probably last longer. The 75-ft length of hose placed the buoy beyond the point where the groundline entered the water

*Figure 10: One inch Trident hose buoy line crossing over groundline.*
*F/V Jitterbug*

Two other vessels then used Lindow’s 1 1/8-in inch Rule-type prototype buoy line. Results were varied.

As described earlier, the F/V *Cape Fear* is a 32 ft LOA twin jet bowpicker. In conjunction with the weighted groundline testing, Eckley deployed the 75 ft prototype buoy line off the port aft cabin handrail. Conditions were foggy, calm, no swell.

*Figure 11: Deploying Rule hose buoy line.*
*F/V Cape Fear*

When sidesetting at this speed, the groundline enters the water within 0 – 10 ft (0 – 3.3 m) aft of the setting roller amidships. The groundline runs from the boat to the water very close to the vessel hull, entering the water near the stern. Occasionally the line entered the water as much as 2 ft past the stern of the boat, but this was very rare. No contact was made between the protected buoy line and the groundline.

The F/V *Salmo* is a 30 ft LOA single outdrive bowpicker. Herschleb used the 1 1/8-in Rule-type prototype buoy line on two occasions, and snagged the buoy line once. The conditions were similar in both tests: foggy, calm, and no wind. The vessel setting speed was 2.8 knots. The snagging (two hooks caught at once) occurred when the vessel made a radical starboard-to-port turn, and the buoy line was dragged over the groundline. Herschleb commented this was a radical turn and not common. On another set under similar conditions, Herschleb deployed the prototype for approximately one half hour. No snagging occurred. He found the softer lay Rule hose easy to handle and stow.

Results from Project 4: Lighter-weight Streamer Line

The CDFU group proposed to test adaptations to streamer lines currently required for smaller vessels with standing rigging. The problem with the heavy USFWS-issued streamer lines for smaller vessels has been an inability to maintain the streamer aloft. This is viewed primarily as a problem of slower setting speeds for smaller vessels coupled with a relatively heavy streamer line. Recent research in Alaska focused on using different types of drags with the USFWS streamer at various setting speeds to achieve the performance standards. In 2002, Melvin tested 15 different kinds of drag configurations towed at varying speeds on a small vessel in Sitka, but nothing tested allowed the USFWS streamer to reach the performance standard (unpublished data, Melvin 2002).

Dan Hull, captain of the F/V *Gretchen S*, was aware of Melvin's work in Sitka, and was interested in testing and documenting a lighter-weight version of the USFWS streamer line he has been using. Hull's prototype is made entirely of white parachute cord. For better contrast while filming, we added bright pink cotton landscaping string to the drop lines. Hull's line is lightweight (2 verses 5 lbs), uncomplicated to deploy and easy to store. A plastic milk jug half filled with water was used as the drag, and is easy to handle. The jug doesn't dive underwater which aids in visually keeping track of the end of the streamer from the vessel. If the jug were to break away from the streamer, it sinks and will not float as plastic litter.

Throughout the weighted groundline testing in Project 3, we observed and filmed both streamer lines. Below is a schematic comparison of the two streamers.

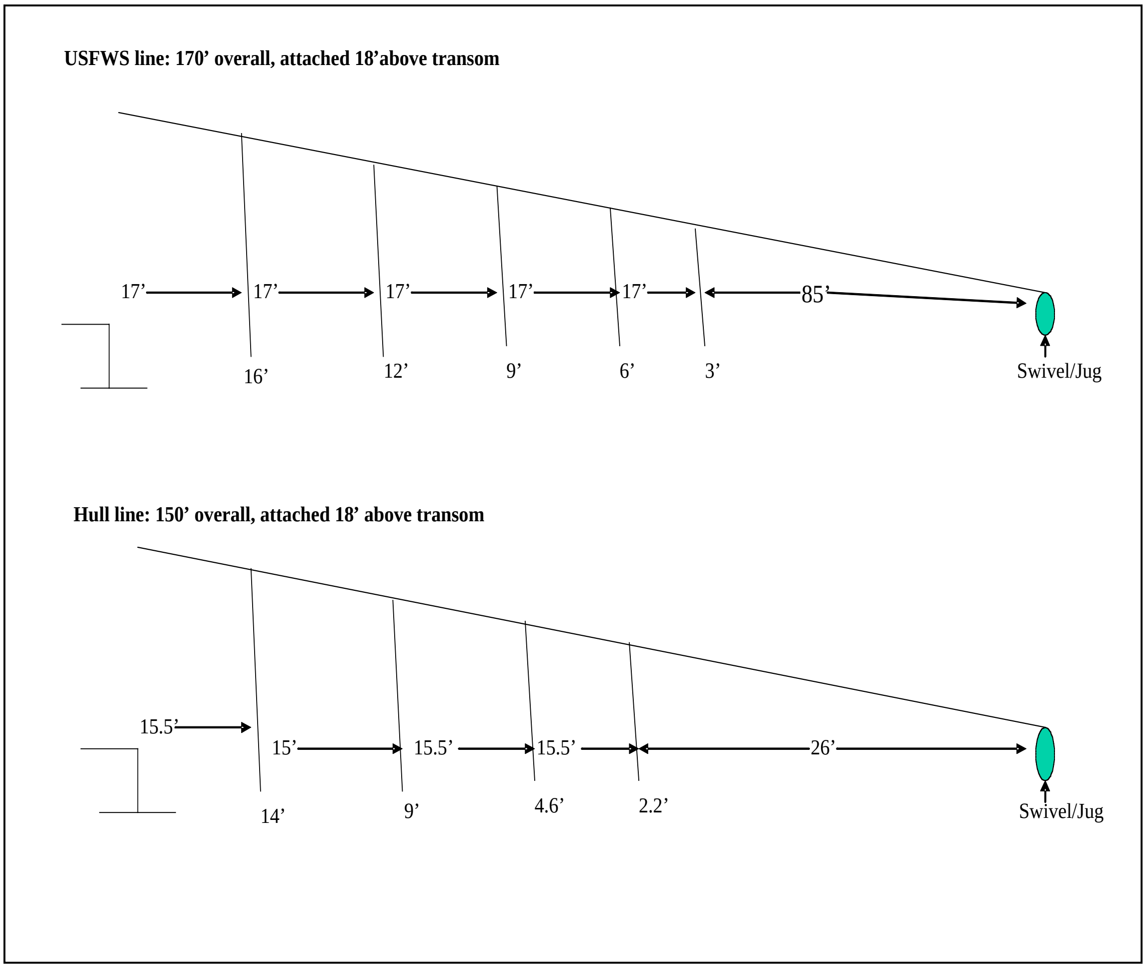


*Figure 12: USFWS streamer line and Dan Hull's adaptation.*

*Figure 13: USFWS streamer line (left) and Hull line and jug (right).*

In winds less than 15 knots, light seas (less than 2-ft waves, no swell), and setting speeds of 2.8 to 3.2 knots, Hull's streamer line reached the performance standard. On the downside, once the setting speed dropped to 2.3 knots (which is rare), Hull's streamer drooped and became ineffective. We weren't able to observe either type of gear operate in heavier seas. Hull reports the heavy USFWS line has never reached performance standards at his setting speeds, and the line is especially bothersome to handle in rough seas.

## Project 5: Sidesetting as a Seabird Avoidance Measure

Terry Smith of the F/V *Lady Viking* submitted a proposal to test the idea that when longline gear is set off the side of the vessel, the vessel itself acts as deterrent to birds attacking the bait. His observation had been that flying seabirds avoid approaching too close to a vessel. If an approach range could be established and bait deployed within that area, he felt bird attacks on hooks would be minimized.

No research could be found on this proposed "shadow" effect of the vessel. In 2000, Melvin, et. al. found over 90% of all seabird attacks on baited hooks occurred between 10 m and 50 m astern of research vessels longlining for sablefish using no bird deterrent. The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) regulations use a target sink rate performance standard of 0.3 meters/second for bird deterrence, but it is unclear whether that rate was determined using a maximum speed of bird dives, or a minimum distance behind the vessel that a bird will approach sinking bait.

In this project, we measured the effectiveness of sidesetting against both the 0.3 m/s sink rate and a theoretical 10 m boat "shadow."

### Vessel Description

Smith owns the F/V *Lady Viking*, a 34 ft LOA bowpicker. A chute for deploying gear is mounted on the port side 6.5 m ahead of stern. Groundline, attached gangions, and hooks are deployed conventionally from tubs placed on the deck below the chute. The gear is set with the vessel traveling forward. As the groundline is deployed, the baited hooks drop to the water about 6 m fore of the stern.

### Groundline Sink Rate Methods

The same bottle test protocol used in Projects 2 and 3 was used in testing sidesetting. An improvement made to the protocol was to measure the distance astern of the vessel that the bottle flipped against a buoy line flagged at 5 m (16.46 ft) intervals and towed behind the vessel.

### Results for Project 5

The first test set consisted of 5 skates of 1/2-in line rigged with gangions approximately 90 cm long baited with chum salmon. A buoy line was towed behind the vessel with flagging every 5 m up to 20 m to estimate the distance aft of the stern that bottles flipped. Conditions were calm and current was slack. Vessel speed was between 4 and 4.6 knots. Gear was set at depths ranging from 30 to 80 fathoms (54.86 to 146.30 m). Bottles were snapped onto the gear as it was deployed through the chute at a rate of three per skate. Care was taken to avoid attaching bottles near skate junctions to avoid the affect of the weights attached at each junction.

Fifteen bottles were deployed, and twelve data points were recorded. Two bottles were missed and the bottle line became wrapped around the main line on another. Flip times for the remaining bottles ranged from 19 to 27 s with a mean flip time of 23.58 seconds. Sink rates for these bottles ranged from 0.074 to 0.105 m/s. The mean sink rate for this set was 0.086 m/s, less than one third the target rate of 0.3 m/s.

Bottles flipped so far beyond the 20 m buoy that it was impossible to estimate the distance from the stern in all but one instance. However, distance behind the vessel can be calculated using the flip time and the forward speed of the vessel. A vessel traveling 4.3 knots/hr or 2.21 m/s would have traveled 53.19 m in the average flip time of 23.58 seconds. Accounting for the approximate distance ahead of the stern that the bottles entered the water because of sidesetting (6.5 m), the distance behind the vessel that the groundline sunk to 2 m could be approximated at 46.7 m, which is beyond the proposed 10 m vessel "shadow."

A second set also consisted of 5 skates of 1/2-in line rigged with gangions approximately 90 cm long baited with chum salmon. Conditions remained calm, but the current had increased to about 0.5 knots. The vessel was headed 109 degrees into the current. Gear was set at depths ranging from 50 to 80 fathoms. In an attempt to increase sink rate, the vessel slowed to set at between 3.5 and 3.8 knots. Bottles were again snapped onto the gear as it was deployed through the chute at a rate of three per skate, but three bottles were also attached close to the weight already attached at the skate junction. These were bottles numbered 6, 9, and 12. Results are shown in Table 10.

Mean sink rate for those bottles not immediately adjacent to weights was 0.114 m/s or faster than in the first set, but still far slower than the target rate of 0.3 m/s. Mean sink rate for the bottles adjacent to weights (numbers 6,9, and 12) was 0.8 m/s or well above the target rate.

Using the calculation method described above and the decreased setting rate (3.5 kts/hr or 1.80 m/s), distance behind the vessel that the bait sunk to 2 m can be calculated at about 27.7 m behind the vessel. When all bottles are included, the average flip time is 15 seconds, which would mean that the bait sank to 2 m about 22 m behind the vessel.

No seabirds were encountered or seen during setting or hauling.

**Table 10: *F/V Lady Viking* Groundline Sink Rates**

| Bottle # | Flip time (s) | Flip Distance (m) behind stern | Sink rate (m/s) |
|---|---|---|---|
| 1 | 11 | > 20 | .181 |
| 2 | 24 | > 20 | 0.083 |
| 3 | 21 | > 20 | 0.095 |
| 4 | 25 | > 20 | 0.08 |
| 5 | 23 | > 20 | 0.087 |
| 6 [a] | 4 | < 5 | 0.5 |
| 7 | 23 | > 20 | 0.087 |
| 8 [a] | 2 | 3 m before stern | 1.0 |
| 9 | 17 | > 20 | 0.118 |
| 10 | 19 | > 20 | 0.105 |
| 11 [a] | 2 | 3 m before stern | 1.0 |
| 12 | 16 | > 20 | 0.125 |
| 13 | 11 | > 20 | 0.181 |
| | | | |
| | | | |
| Mean all bottles | 15.23 | | 0.28 |
| Sink time (to 2 m) near junction weights | 2.67 | | 0.8 |
| Sink time (to 2m) away from junction weights | 19 | | 0.114 |
| | | | |

[a] Bottle was attached next to weights at skate junction.

Discussion

The target sink rate was not achieved in any of our tests, nor was the theoretical target distance (10 m) behind the vessel at which hooks reach a depth of 2 m achieved, except in the case of three bottles that were attached immediately adjacent to weights. The number of weights Smith customarily uses per skate (3) was not enough to bring the average distance behind the vessel below 10 m. Additional weight can be added to the line to reach the target sink rate (and, through calculations, the target distance), as is discussed in Project 3.

## Project 6: Water Stream as a Seabird Avoidance Measure

Emmet Heidemann of the F/V *Sonship Too* proposed to adapt a net washdown system commonly used on gillnetters to achieve a spray of water off the bow or stern of the vessel that, if broad and long enough, would form a curtain of water over sinking baited longline hooks to deter seabird attacks.

The F/V *Sonship Too* is a 34 ft LOA bowpicker used for gillnetting in the Kenai area. Prior to testing, Heidemann purchased and adapted a 3” Pacer pump to create an area of water spray fore of the vessel when setting in reverse. As shown in Figure 1, the output hose was connected to a 3-ft section of PVC pipe. Sixteen holes were drilled into the PVC at 2-in intervals to create a spray head, which was attached to the roller at the bow of the vessel.

*Figure 14: The water-spray device developed by Heidemann.*

Methods

A buoy line was flagged at 1-m intervals, with flags changing colors every 10 meters. This line was towed by the vessel as the spray system was deployed. Distance fore of the bow where the water spray hit the water was estimated using this line as a measuring device. Length and width of the spray curtain was estimated by the project coordinator and documented with still footage. No gear was set during testing.

<u>Results</u>

Six trials of the water spray system were tested on August 6, 2004. Winds were blowing at 5-6 knots directly at the port side of the vessel for all trials, and seas were calm.

Trial one tested the system as designed by Heidemann, with 16 1/8-in holes drilled into the PVC pipe and the pipe attached at an angle so that the holes were approximately thirty-five degrees above horizontal. Select holes were widened with a larger drill bit on each successive test, until all sixteen were 3/8-in in diameter in the final trial. In an attempt to maximize the distance fore of the vessel that the spray would reach, the angle of the holes was changed to horizontal for trial five. Little difference was noted, and the angle was returned to 35 degrees above horizontal for the final trial. In all cases, the width of the spray area on the water appeared to be slightly over 1 m.

*Figure 15: Water spray hitting measuring line marked at 5 m intervals.*

The length of the spray area varied with distribution of hole diameters and is recorded in the table below, as is the longest distance fore of the vessel reached by the spray.

**Table 11: *F/V Sonship II* Water Spray Length and Distance**

| Trial | Number and Diameter of holes | Length (m) of spray area on water | Longest distance (m) behind vessel | Comments |
|---|---|---|---|---|
| 1 | 16 -1/8-in | 1 | 20 | Angle of holes at 35 degrees above horizontal |
| 2 | 11- 1/8-in<br>5- 1/4-in | 5 | 20 | |
| 3 | 3 – 3/8-in<br>10 – 1/8-in<br>3 – 1/4-in | 10 | 20-25 | |
| 4 | 6 – 3/8-in<br>10 – 1/8-in | 10 | 20-30 | |
| 5 | same | 10 | 20-25 | Changed angle of holes to approx. horizontal |
| 6 | 16 – 3/8-in | 12- 15 | 20-30 | Returned to 35 degrees |

Finally, the opacity or cloudiness of the water curtain was recorded with still photographs for trials 1, 4, 5, and 6. As the diameter of holes increased, the opacity of the curtain also increased.

*Figure 16: Opacity of spray in Trial 1*

*Figure 17: Opacity of spray in Trial 6*

Throughout most trials, the area of spray on the water remained directly over the buoy line, which was attached to the center of the boat. But, as the wind began to pick up toward the end of testing, the spray curtain began to drift to the windward side of center.

*Figure 18: Water spray as impacted by wind gust.*

No seabirds were seen approaching the vessel during this testing.

Discussion

With this system, a 1.5 m wide by 12-15 m long area can be covered with water spray at a maximum distance behind the vessel of 30 m. The skipper of the vessel believes the 3-in Pacer pump is capable of projecting water twice that distance if an adjustable washdown nozzle is used, but this was not tested.

The effectiveness of this water curtain was not tested for seabird deterrence. It is unclear whether the area of groundline underneath the arc of the water spray would be protected from seabird attacks, or if a direct hit with the spray would deter seabird attacks. Light winds appear to have an effect on the location of the spray area, but an increase in power through the use of a different nozzle might lessen the wind effect.

## Overall Discussion and Recommendations

The objective of this project was to test the logistical practicality of deploying a suite of seabird deterrent methods appropriate for use on small longline vessels (26 to 55 ft LOA) operating in Alaskan waters, and to recommend technologies for further field testing of seabird interaction mitigation.

Project 1 and Project 4 involved testing the practicality of two methods of making compliance with the seabird avoidance regulations currently in place easier. The remaining projects tested the practicality of methods not currently permitted as seabird deterrence methods. None of these projects included testing the effectiveness of the methods at reducing seabird interactions with gear. In no cases were issues of gear cost or enforceability evaluated.

In consultation with project skippers and an advisory committee of industry members and researchers, we conclude:

- No seabirds were seen actively pursuing baited hooks during any of our studies;
- heavier streamer lines currently distributed by Pacific States Marine Fisheries Commission for USFWS are too heavy to be used effectively on many small longline vessels, but lighter-weight streamer lines can achieve the required performance standards;
- construction and use of a davit may allow some smaller vessels to deploy streamer lines away from their gear and thus reduce the chances of fouling;
- reaching desired groundline sink rates by using heavier groundline or by adding additional weight is a serious challenge for a small vessel and international standards for sink rates were not met under test conditions;
- covering buoy drag lines with pliable hose can decrease fouling of buoy lines with halibut gear;
- sidesetting conventional gear from a small bowpicker does not appear to significantly reduce the distance behind the stern that gear sinks to a 2 m depth; and
- a 3-in Pacer pump can be adapted to create a 1.5 m wide by 12-15 m long area of spray on the water at a maximum distance of 30 m behind a vessel. However, light winds can blow this spray off the center plane in which the gear would be sinking.

As a result of this testing, we recommend the following:

- Lighter-weight streamer lines be evaluated for effectiveness in reducing seabird interactions.
- Consideration be given to the design and distribution of lighter-weight lines for use on smaller longline vessels similar to the current program for larger vessels.
- Research on the use of integrated weight groundline on smaller vessels should be continued. Melvin's integrated weighted line being tested on larger boats may

prove viable for 40 to 50 ft LOA class of vessels but might be too heavy for smaller boats.

- Outreach efforts be undertaken to inform smaller vessels about davit designs, design and availability of lighter weight streamer lines, and using covered buoy lines.

## Epilogue

Epilogue: Since the completion of this work, an additional project funded by USFWS was undertaken to create and distribute free lighter-weight streamer lines. Details of this work will be published at www.marineadvisory.org.


## Acknowledgements

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We would like to thank the skippers and crew who participated in this project:

| | |
|---|---|
| F/V *Dues Payer II* | Skipper: Peter Thompson, Kodiak |
| F/V *Gretchen S* | Skipper: Dan Hull, Anchorage |
| F/V *Lady Viking* | Skipper: Terry Smith, Petersburg |
| F/V *Cape Fear* | Skipper: Rob Eckley, Cordova |
| F/V *Salmo* | Skipper: Curt Herschleb, Cordova |
| F/V *Jitterbug* | Skipper: Bill Lindow, Cordova |
| F/V *Sonship Too* | Skipper: Emmet Heidemann, Eagle River |

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