

Prior hook injuries: results from the 2011 IPHC SSA and NMFS trawl surveys

Stephen M. Kaimmer

Abstract

Data on the occurrence of prior hook injuries (PHI) of halibut caught on the standardized stock assessment (SSA) surveys have been collected since 1997. For halibut of all sizes, the incidence of PHIs in 2011 decreased in Areas 2A, 2B, 2C, and 4A-Aleutians, and increased markedly in Area 4A-Bering Sea. Rates remained about the same in other areas. PHI rates remain high in most of Area 4, and particularly so in Area 4D, where the observed rate has stayed at very high levels (25.8%). Overall, the coastwide average PHI rate (8.3%) has decreased slightly since 2010 (down from 8.7%). The PHI rate observed during the National Marine Fisheries Service (NMFS) Bering Sea trawl survey was 3.3%, up from the 3.1% observed in 2010. The rate in the NMFS Gulf of Alaska trawl survey was 3.3%, down from the 5.6% observed in the 2009 survey.

Introduction

The establishment of a coastwide, comprehensive longline survey along the North American west coast by the International Pacific Halibut Commission (IPHC) has provided a unique opportunity to gather information showing geographic differences among components of the Pacific halibut population. In the mid-1990s, halibut fishers began to notice increasing rates of hook injuries from previous captures. Although groundfish and halibut longline harvesters in Alaska are required to practice careful release techniques¹ for all halibut intended for return to the sea, it was suspected that either the regulations were not being observed by all fishers, or that careful release procedures were inflicting worse damage than expected. The IPHC standardized stock assessment (SSA) surveys provide a means of examining geographic and size trends in hook removal injuries across the entire range of halibut in the northeastern Pacific Ocean and southeastern Bering Sea.

In 1997, prior hook injury (PHI) data were collected for the first time during the IPHC coastwide survey. The collection method proved to be successful and allowed us to continue the research of PHI incidence in 1998 and subsequent years. In 1998, the PHI categories were expanded to more closely reflect those used by National Marine Fisheries Service (NMFS) observers. These expanded classifications have provided more detail about the severity of each injury.

Data collection procedures

All halibut captured during the 2011 IPHC SSA survey were examined for the presence of PHIs. PHIs were defined as injuries that appear to have occurred when the fish was being released during a previous capture by hook-and-line gear. Such injuries are observed primarily to the jaw, but may occur to the eye and eye socket, either alone or in conjunction with a jaw injury. The fish may have been hooked recently, in which case the injury should have been easily noticed, or the injury may have happened sometime in the past and the injury would have been scarred-over. Some difficulty in distinguishing between fresh and prior injuries was expected, as prior injuries

¹Accepted careful release techniques include careful shaking, hook straightening, and gangion cutting.

could be mistakenly attributed to the current capture. Additionally, old injuries may have been difficult to completely document, as they may have been healed sufficiently so as to actually mask or hide the injury altogether.

In 1997, each surveyed fish was coded as having an injury, not having an injury, or that the sampler was unsure as to whether an injury was present. In 1998, the observation codes were revised to capture more specific details of each injury, increasing the total number of categories from three to five. The new condition codes were no injury, a minor injury, moderate injury, severe injury, or unknown (Table 1). These categories have been continued through 2011.

For the analysis that follows, IPHC Regulatory Area 4A was divided into two sub-areas: 4A-Bering Sea and 4A-Aleutians. All stations in Area 4A west of 165° 00' W longitude and north of 54° 20' N latitude were designated as 4A-Bering Sea, and the remainder 4A-Aleutians.

Results

Approximately 76,950 halibut were examined during the 2011 IPHC SSA survey (Tables 2 and 3). This is less than the 101,000 halibut examined during 2010. A total of 7,631 standard survey skates were examined in 2011, much fewer than the 10,017 skates examined in 2010. The decrease was due primarily to fishing fewer skates at each station: six in 2011 as opposed to eight in 2010. In the 2011 survey, 6,270 halibut were found to have a prior injury. On a regulatory area basis, the percentage of all halibut with a prior hook injury ranged from a low of 5.3% (Area 2C) to a high of 25.8% (Area 4D) and averaged 8.3% coastwide (Table 3). The 2011 coastwide PHI rate was lower than that of 2010 (8.7%) and also lower than that observed in 2009 (9.0%) (Kaimmer 2011). The incidence of prior hook injuries on the 2011 surveys increased in Areas 2A, 3A, 3B, 4A-Bering Sea, and 4C, and decreased in Areas 2B, 2C, 4A-Aleutians, 4B, and 4D. PHI rates remain high in most of Area 4, and particularly so in Area 4D. For U32 halibut (fork length less than 32 inches or 82 cm) examined during the SSA survey, the overall incidence of PHI was down slightly from that observed in 2010 (5.9% down from 6.2%). By regulatory area, U32 PHI levels stayed the same in Area 2A; increased in Areas 3A, 3B, 4A-Bering Sea, 4B, 4C, and 4D; and decreased in Areas 2B, 2C, and 4A-Aleutians. The highest occurrence of U32 PHI (18.8%) was observed in Area 4D, continuing the potentially significant rise of 17.0% seen in 2010 from the 8.7% seen in 2009. PHI rates in all areas appear to have fluctuated over time (Fig. 1). Rates remain very high in Area 4D, along with a large increase in Area 4A-Bering Sea. Rates continue to fall in Area 4A-Aleutians.

IPHC samplers onboard NMFS trawl surveys in the Bering Sea (annual survey) and the Gulf of Alaska (biennial survey) also gathered PHI data. In the 2011 Bering Sea trawl survey, 1,644 halibut were inspected and PHI rates were determined to be 3.3%, about the same as seen in 2010. In the Gulf of Alaska trawl survey, 3,076 halibut were inspected and PHI rates were determined to be 3.3%, down from the 5.6% observed in 2009 (Table 4).

In 2011, the proportion of moderate prior hooking injuries relative to minor injuries appeared to increase in Areas 2A, 3B, 4A-Aleutians, and 4B compared to 2010, and to decrease in Area 4A-Bering Sea. The frequency distribution in other areas remained relatively unchanged compared to 2010 (*see* Kaimmer (2011) for 2010 data). As has been the usual observation, the proportion of more severe injuries relative to lesser injuries (Fig. 2) remains highest in areas 4B, 4C, and 4D, which were areas that have also had high rates of overall injury.

Since we started collecting PHI data, the incidence of PHIs in the Gulf of Alaska areas has ranged from 4 to 8%, and has not exceeded 10%. This notwithstanding, the widespread nature of high PHIs is demonstrated by localized PHI observation rates of 25% or more from some individual stations within these areas, including stations off the Oregon, Washington, British Columbia, southeastern Alaska, and south of Kodiak Island (Fig. 3). Stations with observed PHI rates between 15 and 25% were widespread over the entire survey range. Overall mean values in the Bering Sea regions have recently been 8% or more, and in Area 4D the value has exceeded 20% for four of the past seven years. In general, a PHI rate of 5 to 15%, and often higher, has been very common at individual locations (Figs. 3 and 4). For example, survey stations along the Bering Sea continental shelf edge, particularly in Area 4D, have shown high rates of PHI (Fig. 4). A high rate of severe injury continued to occur at many of the stations sampled throughout the survey range, especially around the Aleutian Islands and in the southeastern Bering Sea (Fig. 5).

Discussion

The high PHI rates observed on IPHC surveys in the Bering Sea and Aleutians most likely reflect the interception of halibut by the Pacific cod (*Gadus macrocephalus*) groundfish fisheries in those areas (Williams 2006). The impact of halibut PHI likely goes beyond the injured fish that are observed. The PHI observations provide an accounting of only those fish that survived hooking injuries. Studies by IPHC have shown that moderate and severe injuries often kill fish, and that fish that do survive either stop growing or grow at a much-reduced rate (Kaimmer 1994, Kaimmer and Trumble 1997, 1998).

There has to be a relationship between the PHI rate (the tally of those fish that have survived catch and release) and bycatch mortality, but the understanding of that relationship is still elusive. It is clear that the presence of healed hook removal injuries (PHI) in a caught halibut is evidence of prior capture. We know that many halibut are caught and released as unintended bycatch in non-halibut fisheries, as well as U32 halibut released by directed halibut fishers. Intuitively, an increase in the number of observed PHIs seems a bad thing, reflecting less careful handling by fisheries which catch and then release the halibut, with an associated increase in observed PHI. However, many hook removal injuries are minor, and have little if any effect on survival after careful return to the sea. An increase in the PHI rate, at least in the rate of minor injuries, does not necessarily reflect poor handling by fishers. PHI occurrence rates among U32 halibut tend to be about half the rate seen when we consider all halibut caught. The likely interpretation of this result is that the infliction of these injuries does not happen only to smaller-sized halibut, but that injuries continue to accumulate within the stock as the fish survive from year-to-year. In the Bering Sea fisheries, NMFS observer data indicate steady or decreasing rather than increasing halibut mortality from these fisheries over the last decade (Williams 2006). The halibut mortality is a function of both PHI incidence and the severity of individual PHIs. IPHC survey data suggest that, particularly in the last few years, many of the halibut caught in Area 4 have been accumulating a higher proportion of PHIs relative to other areas.

While many fishers undoubtedly handle halibut bycatch with careful release, substantial improvements are unlikely without direct individual incentives for such behavior. The fisher education efforts made in the last decade seem to have only stabilized or reduced the rates of hooking injury. Continued progress in reducing halibut PHI will require the cooperation of all fishers, and may require a more individualized accounting as a disincentive.

Reference

- Kaimmer, S. M. 1994. Halibut injury and mortality associated with manual and automated removal from setline hooks. *Fish. Res.* 20: 165-179.
- Kaimmer, S. M. 2011. Prior hook injuries: Results from the 2010 IPHC SSA and NMFS surveys. *Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2010*: 413-425.
- Kaimmer, S., and Trumble, R. 1997. Survival of Pacific halibut released from longlines: hooking and release methods. *In Fisheries Bycatch: Consequences and Management. Edited by B. Baxter and C. Kaynor. Alaska Sea Grant College Program Rep. No. 97-02, University of Alaska, Fairbanks*: 101-106.
- Kaimmer, S., and Trumble, R. 1998. Injury, condition, and mortality of Pacific halibut bycatch following careful release by Pacific cod and sablefish longline fisheries. *Fish. Res.* 38: 131-144.
- Williams, G. H. 2006. Incidental catch and mortality of Pacific halibut, 1962-2005. *Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2004*: 153-163.

Table 1. Descriptions of the prior hook injury (PHI) categories used on the 1998-2011 stock assessment surveys.

| | Categories only apply to <u>prior</u> hook injuries, if any. Worst injury of jaw, eye, & eye socket prevails. | | | | Did not check or can't tell |
|---------------------------------|--|---|--|--|--|
| Injury locations | None | Minor | Moderate | Severe | Unknown |
| Jaw | No injury | Jaw in one piece, not split or separated from head. Skin of lip may be torn, but jaw is intact. | Upper or lower jaw bone may be torn through, hanging from fish, or torn away on either side of the head. Tear may or may not include tearing through the cheek area. Lower or upper jaw may be split laterally, tearing through either snout or lower mouth. | Removal of hook has torn large flap from side of head, usually originating in cheek area. Flap, usually including part of jaw, is either hanging loosely or missing. | Did not examine the fish, or can't tell. |
| Eyeball & eye socket | No injury | Eye socket may be torn, but eyeball is undamaged. | Eyeball punctured. | | Did not examine the fish, or can't tell. |

Table 2. Prior hooking injury (PHI) data collected on 2011 standardized stock assessment grid survey. Length group definitions: U32 is ≤ 81 cm; O32 is ≥ 82 cm (32 in). This table does not include 1,282 halibut for which the length was not recorded.

| Reg. Area | Length Group | Injuries | | | | | | | | | | |
|--------------------|--------------|----------|-------|-------|-------|----------|-------|--------|------|---------|-------|--------|
| | | None | | Minor | | Moderate | | Severe | | Unknown | | Total |
| | | No. | % | No. | % | No. | % | No. | % | No. | % | |
| 2A | U32 | 316 | 97.2% | 7 | 2.2% | 2 | 0.6% | | 0.0% | | 0.0% | 325 |
| | O32 | 787 | 92.2% | 49 | 5.7% | 14 | 1.6% | | 0.0% | 4 | 0.5% | 854 |
| | Total | 1,103 | 93.6% | 56 | 4.7% | 16 | 1.4% | | 0.0% | 4 | 0.3% | 1,179 |
| 2B | U32 | 2,489 | 92.4% | 146 | 5.4% | 23 | 0.9% | 3 | 0.1% | 32 | 1.2% | 2,693 |
| | O32 | 3,296 | 89.8% | 281 | 7.7% | 75 | 2.0% | 3 | 0.1% | 14 | 0.4% | 3,669 |
| | Total | 5,785 | 90.9% | 427 | 6.7% | 98 | 1.5% | 6 | 0.1% | 46 | 0.7% | 6,362 |
| 2C | U32 | 2,558 | 94.7% | 61 | 2.3% | 14 | 0.5% | 2 | 0.1% | 67 | 2.5% | 2,702 |
| | O32 | 3,519 | 89.7% | 210 | 5.4% | 45 | 1.1% | 5 | 0.1% | 142 | 3.6% | 3,921 |
| | Total | 6,077 | 91.8% | 271 | 4.1% | 59 | 0.9% | 7 | 0.1% | 209 | 3.2% | 6,623 |
| 3A | U32 | 16,453 | 94.3% | 788 | 4.5% | 112 | 0.6% | 2 | 0.0% | 99 | 0.6% | 17,454 |
| | O32 | 13,247 | 88.5% | 1,274 | 8.5% | 272 | 1.8% | 7 | 0.0% | 166 | 1.1% | 14,966 |
| | Total | 29,700 | 91.6% | 2,062 | 6.4% | 384 | 1.2% | 9 | 0.0% | 265 | 0.8% | 32,420 |
| 3B | U32 | 13,685 | 92.6% | 770 | 5.2% | 182 | 1.2% | 8 | 0.1% | 131 | 0.9% | 14,776 |
| | O32 | 5,625 | 85.4% | 679 | 10.3% | 167 | 2.5% | 7 | 0.1% | 106 | 1.6% | 6,584 |
| | Total | 19,310 | 90.4% | 1,449 | 6.8% | 349 | 1.6% | 15 | 0.1% | 237 | 1.1% | 21,360 |
| 4A-Aleu | U32 | 2,131 | 92.3% | 86 | 3.7% | 11 | 0.5% | | 0.0% | 82 | 3.5% | 2,310 |
| | O32 | 829 | 88.5% | 68 | 7.3% | 17 | 1.8% | 2 | 0.2% | 21 | 2.2% | 937 |
| | Total | 2,960 | 91.2% | 154 | 4.7% | 28 | 0.9% | 2 | 0.1% | 103 | 3.2% | 3,247 |
| 4A-BSea | U32 | 733 | 85.0% | 72 | 8.4% | 24 | 2.8% | 1 | 0.1% | 32 | 3.7% | 862 |
| | O32 | 832 | 74.5% | 172 | 15.4% | 79 | 7.1% | 1 | 0.1% | 33 | 3.0% | 1,117 |
| | Total | 1,565 | 79.1% | 244 | 12.3% | 103 | 5.2% | 2 | 0.1% | 65 | 3.3% | 1,979 |
| 4B | U32 | 552 | 76.8% | 31 | 4.3% | 6 | 0.8% | 1 | 0.1% | 129 | 17.9% | 719 |
| | O32 | 1,104 | 84.3% | 66 | 5.0% | 38 | 2.9% | 3 | 0.2% | 98 | 7.5% | 1,309 |
| | Total | 1,656 | 81.7% | 97 | 4.8% | 44 | 2.2% | 4 | 0.2% | 227 | 11.2% | 2,028 |
| 4C | U32 | 402 | 87.0% | 41 | 8.9% | 17 | 3.7% | | 0.0% | 2 | 0.4% | 462 |
| | O32 | 205 | 67.4% | 48 | 15.8% | 35 | 11.5% | | 0.0% | 16 | 5.3% | 304 |
| | Total | 607 | 79.2% | 89 | 11.6% | 52 | 6.8% | | 0.0% | 18 | 2.3% | 766 |
| 4D | U32 | 388 | 78.7% | 63 | 12.8% | 25 | 5.1% | 2 | 0.4% | 15 | 3.0% | 493 |
| | O32 | 312 | 63.3% | 93 | 18.9% | 60 | 12.2% | | 0.0% | 28 | 5.7% | 493 |
| | Total | 700 | 71.0% | 156 | 15.8% | 85 | 8.6% | 2 | 0.2% | 43 | 4.4% | 986 |
| Grand total | | 69,463 | 90.3% | 5,005 | 6.5% | 1,218 | 1.6% | 47 | 0.1% | 1,217 | 1.6% | 76,950 |

Table 3. Summary of PHI data collected during the 2011 standardized stock assessment grid survey. This table does not include 1,217 halibut where the PHI was coded as 'unknown'.

| Reg. Area | No. of sets | No. std. skates | All halibut ¹ | | | | U32 halibut (<82 cm) | | | |
|--------------|-------------|-----------------|--------------------------|-----------------|---------------|-------------------------|----------------------|---------------|-------------------------|--|
| | | | No. examined | No. with injury | % with injury | No. inj. per std. Skate | No. with injury | % with injury | No. inj. per std. skate | |
| 2A | 107 | 623 | 1,175 | 72 | 6.1% | 0.12 | 9 | 2.8% | 0.01 | |
| 2B | 170 | 1,018 | 6,316 | 531 | 8.4% | 0.52 | 172 | 6.5% | 0.17 | |
| 2C | 123 | 736 | 6,414 | 337 | 5.3% | 0.46 | 77 | 2.9% | 0.10 | |
| 3A | 372 | 2,231 | 32,155 | 2,455 | 7.6% | 1.10 | 902 | 5.2% | 0.40 | |
| 3B | 229 | 1,375 | 21,123 | 1,813 | 8.6% | 1.32 | 960 | 6.6% | 0.70 | |
| 4A-Aleu. | 52 | 312 | 3,144 | 184 | 5.9% | 0.59 | 97 | 4.4% | 0.31 | |
| 4A-Bsea | 59 | 355 | 1,914 | 349 | 18.2% | 0.98 | 97 | 11.7% | 0.27 | |
| 4B | 87 | 517 | 1,801 | 145 | 8.0% | 0.28 | 38 | 6.4% | 0.07 | |
| 4C | 19 | 114 | 748 | 141 | 18.9% | 1.23 | 58 | 12.6% | 0.51 | |
| 4D | 58 | 349 | 943 | 243 | 25.8% | 0.70 | 90 | 18.8% | 0.26 | |
| Total | 1276 | 7,631 | 75,733 | 6,270 | 8.3% | 0.82 | 2,500 | 5.9% | 0.33 | |

¹ Numbers do not include fish with PHI coded Unknown (i.e., unknown, forgot to check, can't tell)

Table 4. Prior hook injury data collected by IPHC samplers on the 1998-2010 National Marine Fisheries Service trawl surveys. Note that the Gulf of Alaska survey is biennial, whereas the Bering Sea survey is annual.

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|-------------------------------|------|-------|------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| Bering Sea halibut | | | | | | | | | | | | | |
| Total number examined | 903 | 831 | 661 | 1,002 | 843 | 835 | 883 | 2,955 | 1,570 | 1,711 | 1,844 | 1,855 | 1,664 |
| Number without injuries | 839 | 814 | 630 | 958 | 54 | 806 | 846 | 2,905 | 1,535 | 1,670 | 1,775 | 1,800 | 1,609 |
| Minor injuries | 24 | 6 | 24 | 30 | 45 | 23 | 20 | 24 | 20 | 18 | 42 | 26 | 30 |
| Moderate injuries | 28 | 6 | 7 | 12 | 9 | 4 | 15 | 13 | 12 | 23 | 18 | 25 | 25 |
| Severe injuries | 12 | 5 | - | 2 | - | 2 | 1 | 1 | 3 | 0 | 5 | 4 | - |
| Unknown or not examined | - | - | - | - | - | - | 1 | 12 | 4 | 0 | 4 | 0 | - |
| Percent with PHI | 7.1% | 2.8% | 4.7% | 4.4% | 6.3% | 3.5% | 4.2% | 1.3% | 2.2% | 2.3% | 3.5% | 3.1% | 3.3% |
| Gulf of Alaska halibut | | | | | | | | | | | | | |
| Total number examined | - | 2,347 | - | 3,176 | - | 8,954 | 2,599 | - | 2,598 | - | 5,228 | - | 3,076 |
| Number without injuries | - | 2,279 | - | 3,083 | - | 8,248 | 2,505 | - | 2,472 | - | 3,252 | - | 2,968 |
| Minor injuries | - | 23 | - | 34 | - | 30 | 34 | - | 73 | - | 137 | - | 48 |
| Moderate injuries | - | 26 | - | 46 | - | 82 | 51 | - | 45 | - | 48 | - | 51 |
| Severe injuries | - | 19 | - | 5 | - | 10 | 7 | - | 6 | - | 6 | - | 2 |
| Unknown or not examined | - | - | - | 8 | - | 584 | 2 | - | 2 | - | 1,785 | - | 7 |
| Percent with PHI | - | 2.9% | - | 2.7% | - | 1.5% | 3.6% | - | 4.8% | - | 5.6% | - | 3.3% |

Percent of observed halibut with any PHI



Figure 1. Trends in the percent of halibut observed with any prior hook injuries (PHI) during the 1997-2011 IPHC standardized stock assessment (SSA) surveys.

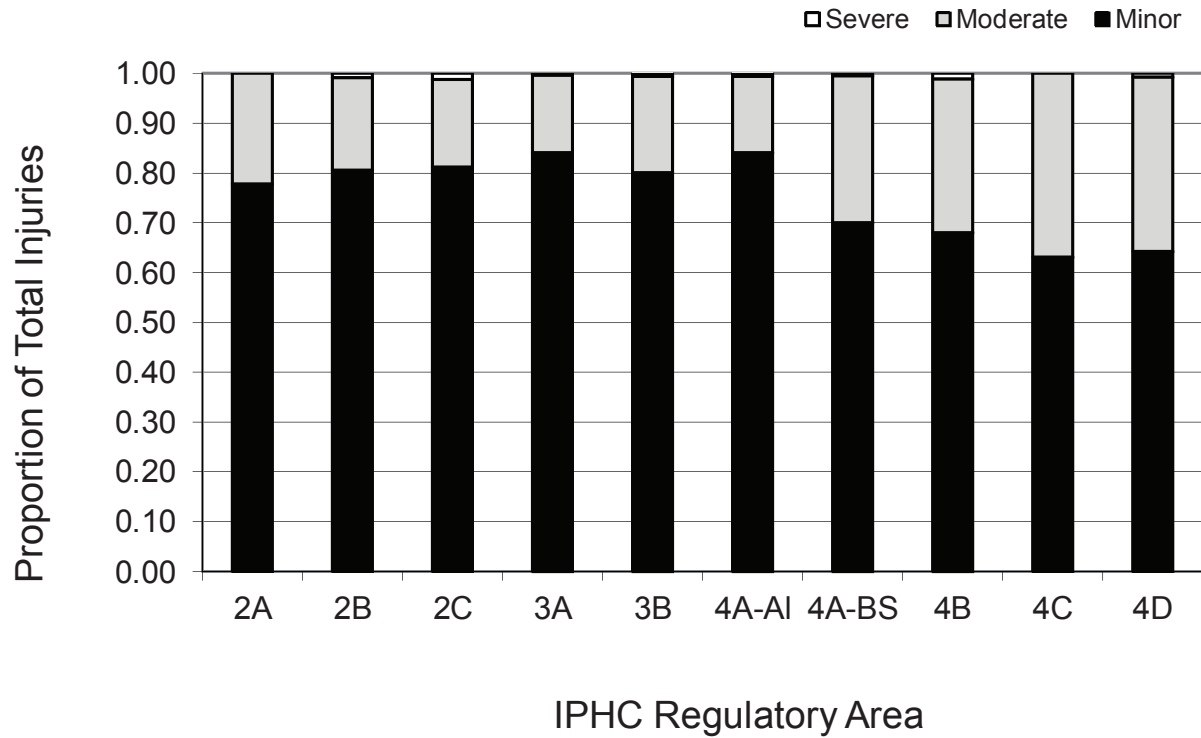


Figure 2. Frequency distribution of injury severity for fish with injuries sampled during the 2011 standardized stock assessment survey. For Regulatory Area 4A, AI = Aleutians and BS = Bering Sea.

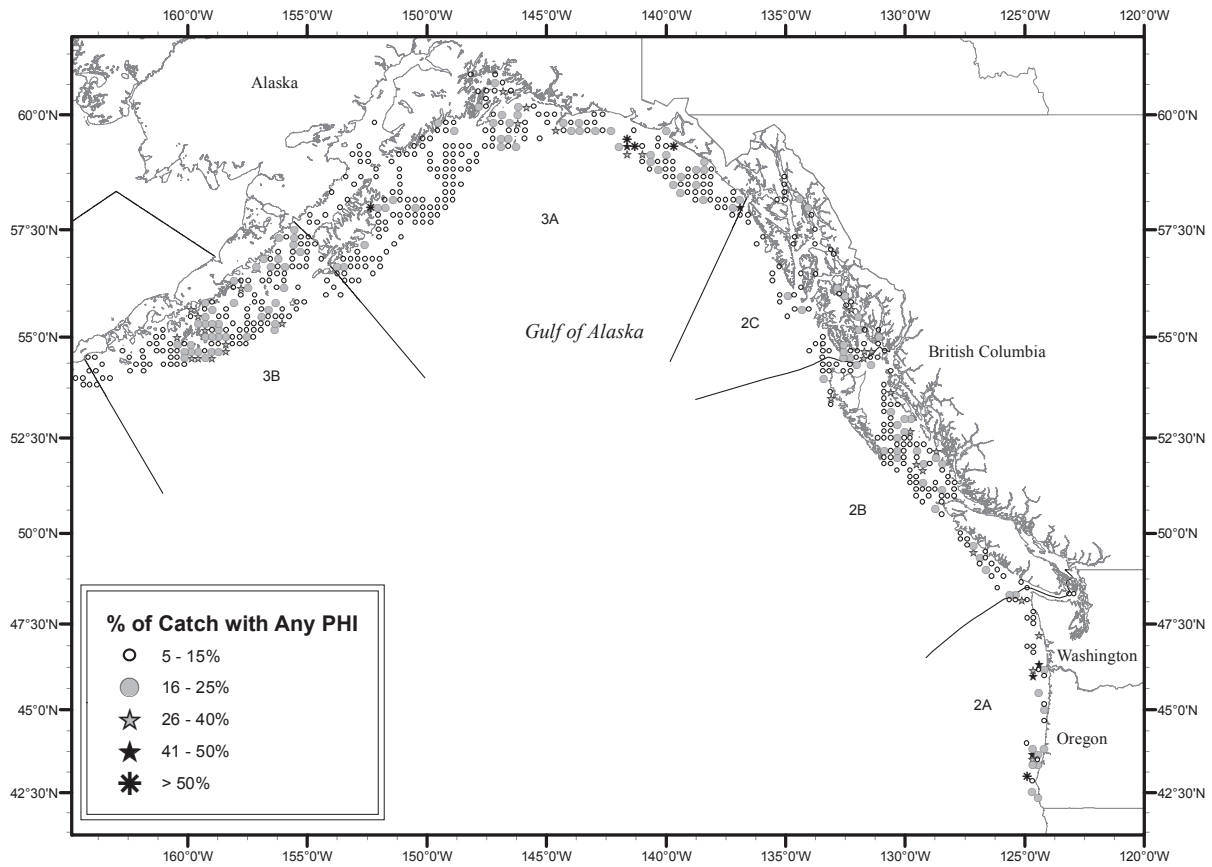


Figure 3. Spatial distribution of the proportion of prior hook injuries (PHI) among observed halibut in the Gulf of Alaska, British Columbia, and U.S. West Coast standardized stock assessment survey regions in 2011. Stations with <5% PHI observed are not shown because PHIs are common throughout the geographic range

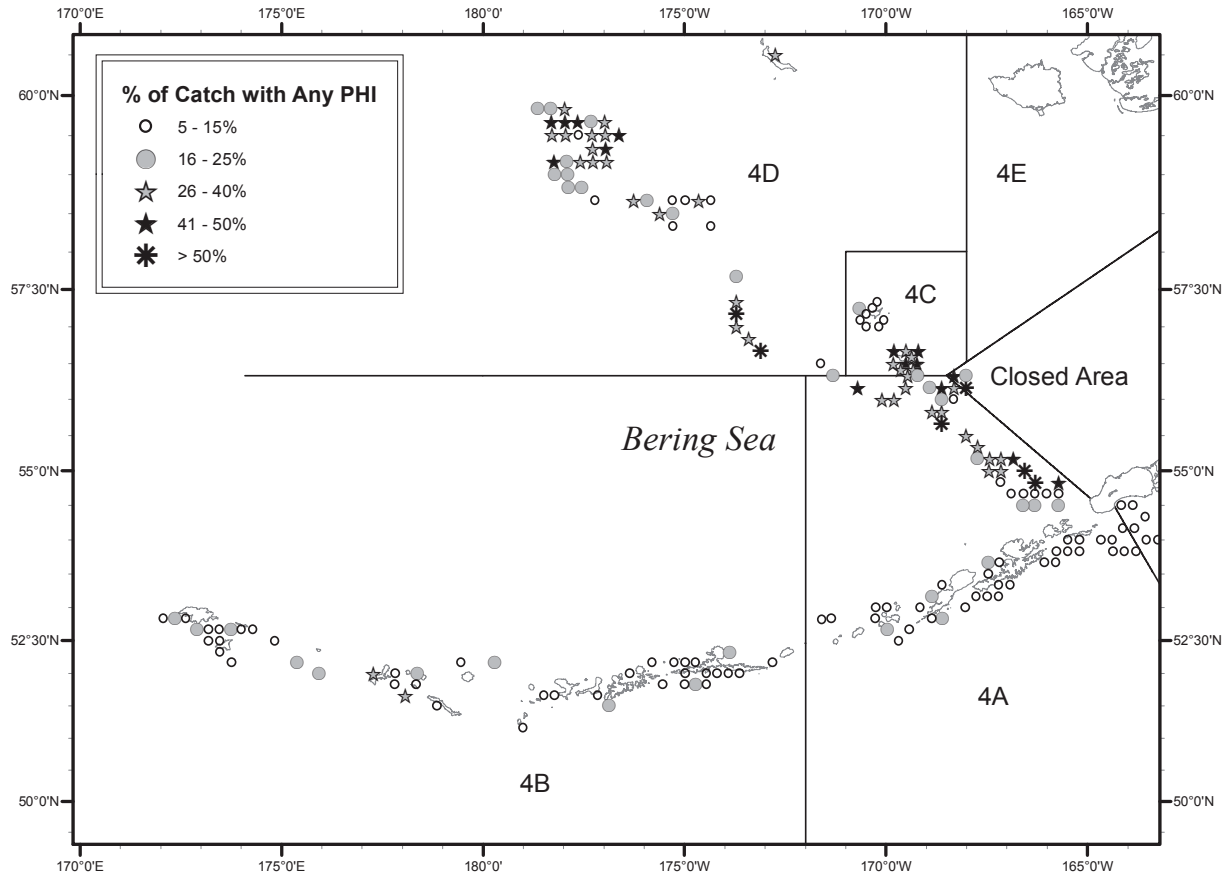


Figure 4. Spatial distribution of the proportion of prior hookinjuries (PHIs) among observed halibut in the far western Gulf of Alaska and Bering Sea standardized stock assessment survey regions in 2011. Stations with <5% PHI observed are not shown because PHIs are common throughout the geographic range

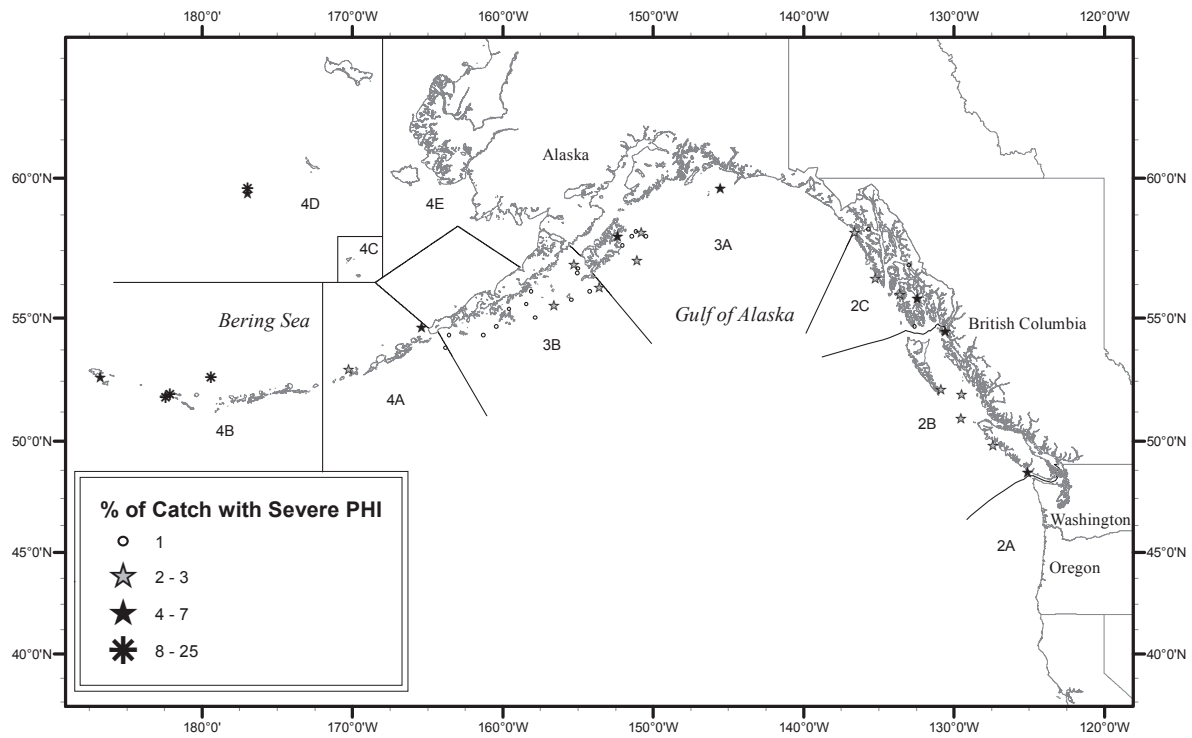


Figure 5. Proportion of severe prior hook injuries (PHI) among halibut observed in the 2011 standardized stock assessment survey, according to station location. Stations with less than four halibut or with no observed severe PHI are not shown.

