GROUNDFISH MANAGEMENT TEAM INFORMATIONAL REPORT ON SABLEFISH AND LINGCOD DISCARD MORTALITY RATES

As part of the Omnibus process, the Council recommended that an individual fishing quota (IFQ) survival credit for discarded lingcod and sablefish be considered (Agenda Item G.6. Attachment 2, June 2016). To start that process, the GMT reviewed the most current research and information to evaluate whether updates to the discard mortality rates are warranted, before expanding their use to the IFQ program. See Attachment 1 for a summary of the information reviewed by the GMT.

Currently, annual estimates of groundfish mortality prepared by the West Coast Groundfish Observer Program (WCGOP) include discard mortality credits for sablefish and lingcod. These rates are; 50 percent for trawl caught lingcod and sablefish, 20 percent for longline caught sablefish, and 7 percent for longline caught lingcod. However, within the shorebased IFQ program, based on actions taken under Amendment 20, total catch, regardless of survival, is debited from vessel quota pound (QP) accounts. This catch is tracked inseason against the trawl allocation and annual catch limits (ACLs) and there is no postseason QP adjustment.

Sablefish

Trawl

While the GMT previously recommended and the Council adopted the use of 50 percent discard mortality for trawl caught sablefish, there have been very few studies on the survival of discarded sablefish. In order to move forward with considering these survival credits for the IFQ fishery, the GMT examined the available research to either confirm or change the existing 50 percent discard mortality rate. As mortality is a result of the cumulative stress from temperature, tow duration and age of fish, the GMT analyzed the impact of these parameters for the West Coast trawl fishery.

Results from a study by Davis, Olia, and Schreck (2001) showed that based on a four hour tow time, discard mortality increases with temperature. Figure 1 shows the span of tow times (hours) for all observed trawl trips from 2002-2015 using WCGOP haul level observer data. Outliers were removed for confidentiality purposes. When Davis et al. (2001) did their study a four hour tow time (shown by dotted line) was used to assess discard mortality. Since the implementation of the IFQ program in 2011, there has been a statistically significant decline in the average tow time (pre-IFQ = 4.27 hours, IFQ = 2.73 hours). To the extent that all other variables remain the same, a decrease in tow time would be expected to decrease mortality. However, gear innovations and changes in strategy may lead to fuller nets (i.e., increased catch per unit effort), causing more stress to the fish due to being more crowded.

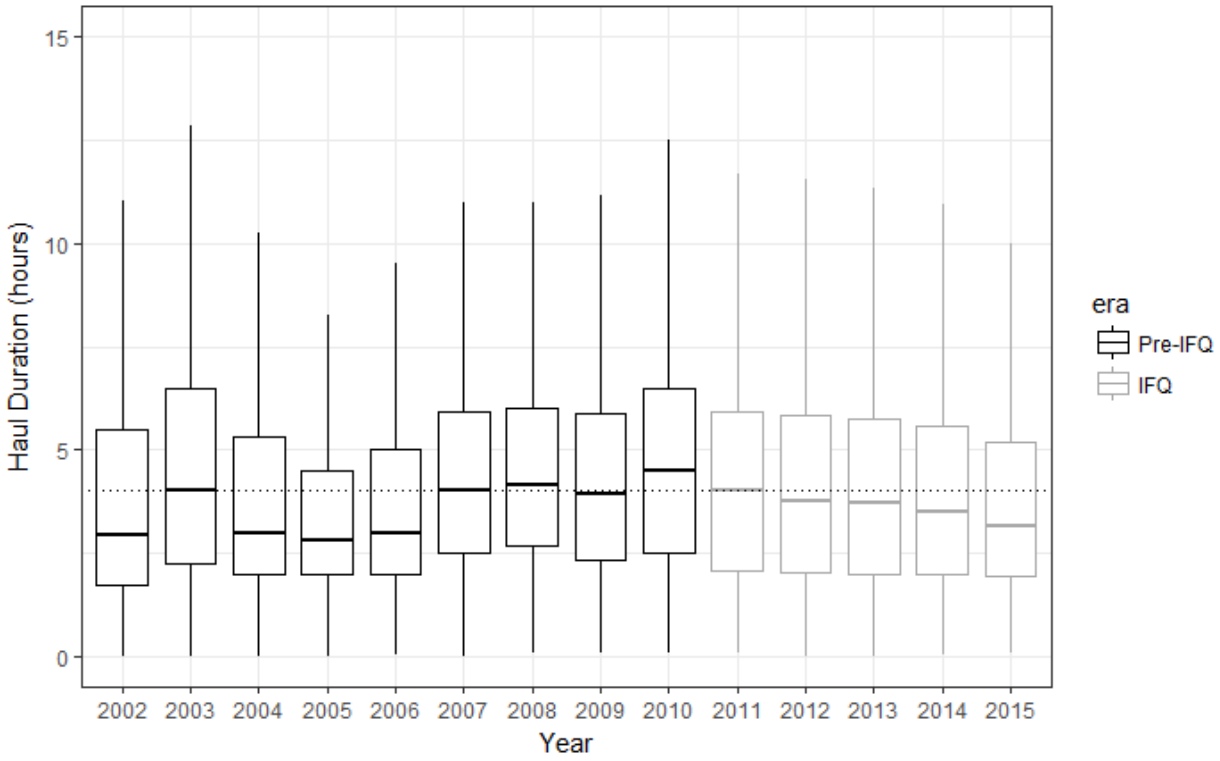

Figure 1: Average haul duration (hours) on trawl trips from 2002-2015. Dashed line represents the 4 hour tow time used in the Davis et al. study.

To evaluate the effects of temperature on discard mortality rates, the GMT: (1) obtained sea surface temperature (SST) profiles throughout the range of the sablefish fishery for different regions (to account for regional variability); (2) assigned average SST to the sablefish discarded by region and date; and (3) linked the temperature dependent mortality rates from the Davis et al. (2001) to these temperature specific IFQ discards (stratified by seasons; summer = May-August, winter = September-April). South of 36^0 N. latitude data were stratified at Pt. Conception to account for the vast temperature differentials of the California current and the Southern California Bight.

Using a discard mortality equation estimated from the results of the 2001 study, under the presumption that tow times are close to an average of four hours, Figure 2 shows the average mortality of discarded sablefish by temperature area for 2009, 2010, 2011, and 2015. These years were analyzed to represent varying ocean conditions by including one La Niña and one El Niño year before and after implementation of IFQ. Due to confidentiality, some strata are not shown. The horizontal line depicts the current 50 percent discard mortality used. With the changing climate, the influence of La Niña (2009 and 2011) and El Niño years (2010 and 2015), and seasonal changes, the average discard mortality throughout the four years examined is usually within 20 percent of the 50 percent estimate with some years being more or less conservative. While this does not specifically confirm that 50 percent is the precise discard mortality, it does support its continued use and application for trawl caught sablefish until new information or studies become available that state otherwise.

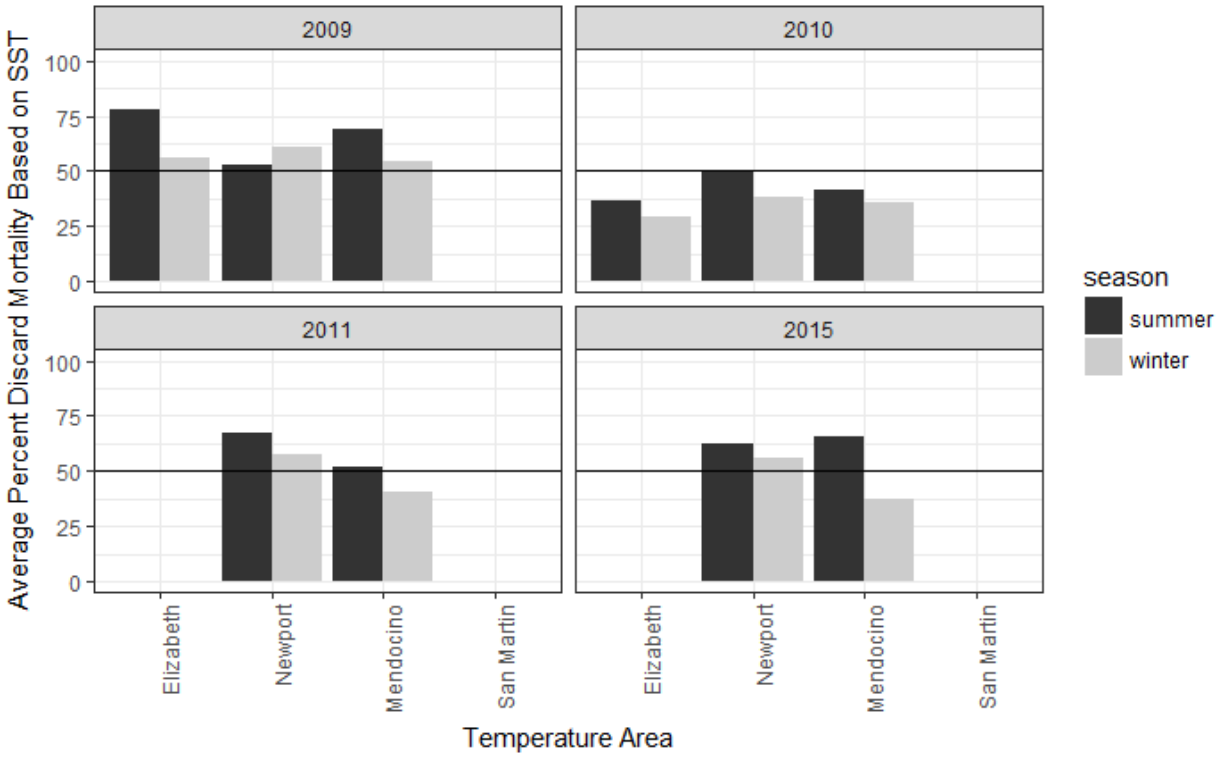

Figure 2: Estimated average percent discard mortality based on SST by regional temperature areas and season. Temperature area key in degrees north latitude: Elizabeth = > 47.35°; Newport = 47.35° - 40.10°; Mendocino = 40.10° - 36.0°; San Martin = 36.0° - 34.5°; San Nicolas (not shown; no landings) = < 34.5°.

Additionally, age plays a factor in the survival of discarded sablefish. Davis (2005) estimated that 56.2 percent of age one fish and 25 percent of age two and older fish died when discarded. The average length-at-age observed in PacFIN data (retained, aged fish) (drawn on 1/10/2017 and provided by John Wallace) was used to assign age one or two+ to the discarded (unaged) sablefish per observed haul from WCGOP. Using this data, any discard sablefish less than or equal to 44.75 cm was classified as age one; anything greater was classified as age two or above.

Using the same temperature areas and years above, the GMT analyzed the average mortality for discarded sablefish based on age (Figure 3). The horizontal black line shows the 50 percent discard mortality. Similar to Figure 2, some strata are not shown due to confidentiality. While this is a simplistic approach to analyzing the discard mortality based on age, it does support the continued use of the 50 percent discard mortality rate.

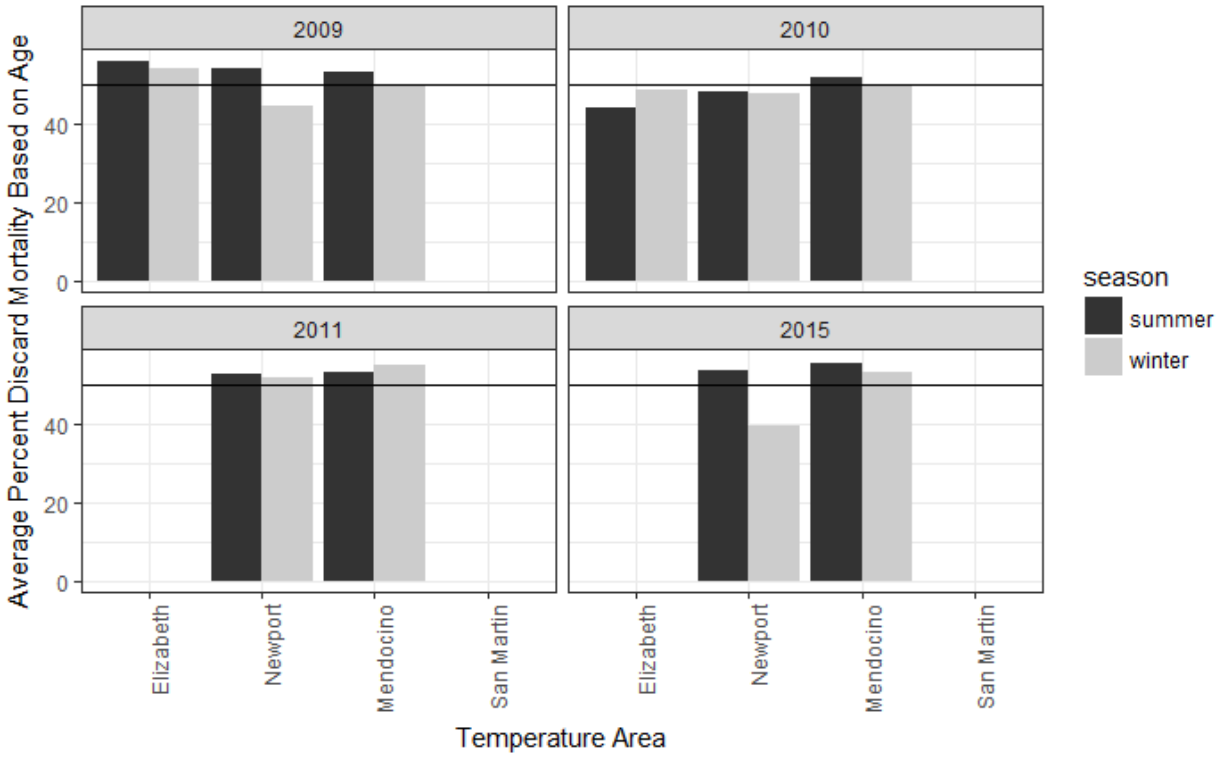

Figure 3: Estimated average percent discard mortality based on age by temperature area and season.

Longline

Results from a research study conducted in Alaska (Stachura et al, 2012) estimated sablefish discard mortality for longline to be 11.7 percent, and as high as 31.99 percent for fish with severe injuries. In Alaska, Dressel (2009) assumed a 25 percent discard mortality rate for sablefish discarded from the Pacific halibut directed fishery, while Schirripa (2008) assumed a 10 percent discard mortality rate for longline gear in the federal Alaska stock assessment. No additional studies have been conducted which would indicate a mortality rate of 20 percent is no longer sufficient to estimate sablefish discard mortality for the longline sector.

The information on the discard mortality rates used for sablefish for the longline and trawl sectors continues to be the best available information and as such, **the GMT recommends no changes to the discard mortality rates at this time.**

Lingcod

Trawl

The GMT reviewed several papers that explored discard mortality for lingcod and found that the basis for the 50 percent discard mortality in the trawl fishery is from a 2003 study that looked at tow duration, fish size and time on deck to estimate actual mortality of trawl-discarded lingcod (Parker et al. 2003). The results of this study showed that regardless of tow duration, lingcod survival was 100 percent for fish discarded immediately after the codend was emptied. Survival decreased with increased time on deck and showed that survival was 50 percent after 30 minutes

on deck. Another study (Davis and Olla, 2002) looked at tow duration, increased air exposure, and temperature for large and small lingcod. This study showed that lingcod mortality increased with temperature and that seasonal increase in both water and air temperatures probably increase mortality compared to cooler seasons.

The GMT discussed the original intent of the IFQ program is to maximize retention and account for all mortality by removing incentives to discard. Considering that there is a minimum size limit for lingcod caught in the trawl IFQ fishery some discard of small lingcod is inevitable. In 2011, the Council considered reducing or removing the lingcod minimum size limit because all catch in the IFQ program would count against quota. No changes were adopted at the time but the Council requested additional analysis of removing and reducing the lingcod size limit which was included in the 2013-2014 Groundfish Harvest Specifications and Management Measures (Section C.8, Appendix C). Such adjustments could be implemented inseason if desired. If requested by the Council, the GMT could provide more discussion on the management implications of removing the lingcod size limit as an alternative to adopting discard mortality credits for the IFQ sector in June.

Longline

Albin and Karpov (1995) is the basis for the seven percent mortality rate that is currently used for lingcod, and all fish without a swim bladder. That study was based on only 15 fish. Albin and Karpov (1998) conducted a follow up study with a larger sample size (69 fish) and an estimated discard mortality of 4.3 percent, with the upper bound of the 95 percent confidence interval at 9.3 percent. Based on these most recent studies and the feasibility to release lingcod sooner under the longline fishing process compared to trawl fishing, the GMT believes that the seven percent rate is still the most appropriate value to use.

The information on the discard mortality rates used for lingcod for the longline and trawl sectors continues to be the best available information and as such, **the GMT recommends no changes to the discard mortality rates at this time.**

Application for Inseason Accounting

The GMT will provide additional input on the potential application and policy considerations of the use of these discard mortality rates for inseason accounting in the IFQ program in June.

References

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ATTACHMENT 1					
Citation	**Species**	**Discard Mortality Rate**	**Gear**	**Location**	**Study Notes**
Parker et al, 2003	lingcod	100% immediate release / 50% for fish released after 30 min on deck	trawl captured - lab monitored	Oregon	Objective to estimate actual mortality of trawl-discarded lingcod (50-84 cm). Study looked at three factors: tow duration, fish size, and time on deck. Survival monitored for 21 days. Results: regardless of tow duration, lingcod survival was 100% for animals discarded immediately after the cod end was emptied. Survival decreased with increased time on deck, 50% survival after 30 minutes on deck. Larger lingcod had higher mortality rates for almost all durations on deck. Improved discard mortality requires changes in fishing behavior. Accurate estimates of discard mortality depends on gathering additional data to understand "average handling". This info could be gathered from observer programs for directed studies on fishing behavior and the process of commercial fishing.
Davis and Olla, 2002	lingcod	None reported	trawl captured - lab monitored	Oregon	Goal of study to look at lingcod mortality by testing different stressors that may control bycatch mortality. The study looked at towing in a net and exposure to increased temperature and air via towing through a thermocline and landing on a deck. Two size classes were studied (41-51 cm and 52-67 cm). Held in the lab for 60 days. Mortality was magnified by a combination of stressors. Exposure to increased temp after 4 hours of towing caused mortality to increase as temp increased between 16 and 20 degrees Celsius. Survivability was improved when fish were released within 30 minutes of capture. Lingcod mortality increased with increasing temperature after net towing.
Albin and Karpov, 1998	lingcod	4.3% (95% C.I. = 0-9.3%)	hook & line	California	Captured lingcod using traditional hook and line gear and held in aquaria to observe general condition. Monterey and Mendocino counties CA. 1 fish died from hooking injury to

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					aorta as landed, 1 died while being transported to lab, 1 died being transported back to ocean for release (total N = 69)
Albin and Karpov, 1995	lingcod	6.66%	sport like rod and reel	California	Captured lingcod using sport-like rod and reel gear, held in aquarium 2-28 days to determine mortality. 15 caught, 1 died due to hooking injury. During holding time, saw hooking wounds visibly heal.
EU Short Study Review of discard mortality for a variety of species	lingcod and sablefish	None reported			The review included studies that investigate the survivability of discarded fish by fishing method. We reviewed the ling and sablefish studies summarized in this report
Davis and Ryer, 2003	lingcod and sablefish	None reported	lab		Feature article in AFSC Quarterly Report summarizes bycatch research at the AFSC from about 1993-2003. Summarizes some of the basic results from other reports reviewed. Sablefish and lingcod have relatively high discard survival because they do not have a swim bladder but mortality is increased due basic fishing practices and increased time on deck.
Stachura et al, 2012	sablefish	11.71% (31.99% for fish with severe injuries)	longline	SE Alaska	inverse relationship to depth of capture; severity of hook injury main factor, along with depth, and amphipod predation; research cruise to tag, fishery intercepts to get tagged fish back
Dressel (2009)	sablefish	assumed 25%	longline	SE Alaska	assumed mortality rate for sablefish discarded in the commercial P. halibut fishery; no data informing rate
Hanselman,et al, 2010	sablefish	assumed 100%	trawl and longline	Alaska	assumed mortality rate for trawl and longline federal groundfish fisheries in Alaska by NMFS, no data informing rate

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Citation	**Species**	**Discard Mortality Rate**	**Gear**	**Location**	**Study Notes**
Schirripa, 2008	sablefish	assumed 10%	longline	Pacific Coast	assumed mortality rate for longline gear applied in federal stock assessment, not data supporting
Davis and Parker 2004	sablefish	No rate specified	laboratory	Oregon	Lab raised juvenile sablefish. Exposed to different temperatures and air times. smaller fish had higher mortality than larger fish Behavior impairments higher with longer time exposed to air
Davis, Olla, Schreck, 2001	sablefish	H&L- 0% at 12C; 16.7% at 14C; 100% at 16C Trawl-33% at 12C; 83% at 14C; 100% at 16C	lab-trawl and H & L	Oregon	tank reared fish age 2+, towed or hooked for 4 hours, then transferred abruptly to warmer sea water (4, 12, 14, & 16 C) for 30 min, then exposed to air for 15 min, survival monitored for at least 60 days. Also looked at elevated levels of stress hormones. Survival was 100% for fish exposed to 12 degrees, 16.7% mortality at 14C, and 100% mortality at 16C. Hooked fish 0% mortality at 12C, 50% mortality at 14C, 100% mortality at 16C. Towed fish--33% mortality at 12C, 83% mortality at 14C, 100% at 16C. Goal of study was to determine if physiological stress indicators could predict mortality which could not
Lupes et al, 2006	sablefish	None reported	lab	Oregon	tested immune system indicators to stress levels, discard mortality is a thing that happens, but no estimate of what the rate might be
Davis, 2005	sablefish	56.2% +/- 13.5% of 1+ age fish; 25.0% +/- 8.4% of 2+ age fish	lab-trawl	Oregon	Lab experiments to ty to determine if possible relationship between behavior impairment and delayed mortality. 2 ages of sablefish towed in a net and exposed to air stressors. Fish injuries notes, behavior impairment noted. Immediate mortality increased with increased time in air, delayed mortality observed up to 35 days after towing and air exposure