Exploration of landings, harvest specification and attainment time series, for stocks of interest in the historical shorebased LE trawl fishery and contemporary IFQ program

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Introduction

Landings, harvest specification and attainment time series for eight stocks of interest in the Shorebased Limited Entry (LE) Trawl Fishery, and Individual Fishery Quota (IFQ) Program were explored with the aim of informing discussion of industry concerns over recent attainment levels for several stocks in the Shorebased IFQ Program. These plots are intended to facilitate informed discussion, rather than present an exhaustive analysis.

The species shown here include Dover sole (Figure 1), lingcod (Figure 2), arrowtooth flounder (Figure 3), English sole (Figure 4), widow rockfish (Figure 5), canary rockfish (Figure 6), petrale sole (Figure 7) and northern sablefish (Figure 8).

The time series stretch from the 1990s through 2010, during trip limit management, and through the IFQ period of 2011 to the present (up to 2015 data included here). Metrics used were those that could be applied over the entire time series to facilitate comparisons among years. Those included landings, since they are available over the entire time series, but discards, and thus total catch estimates have only been available since 2002. Harvest specifications which were the most analogous among years and different management regimes were used; these were Annual Catch Limit (ACL) 2011-2015, Optimum Yield (OY) from 1998-2010, and the groundfish fishery Harvest Guideline (HG) for 1995-1997. Note that here *attainment is expressed as sector landings divided by the OY, HG, or ACL*. This is different from the metric of trawl sector attainment, which typically expresses total catch as a proportion of the sector allocation. A broader metric was necessary since formal allocations have not existed over this entire time series; a unifying metric was needed among years. The range for harvest specification and attainment plots is truncated on some species, due to the lack of harvest specifications in earlier years (e.g. arrowtooth flounder, English sole, petrale sole).

Landings data were queried for shorebased limited entry non-whiting trawl and shorebased limited entry whiting trawl, from the Pacific Fishery Information Network database (PacFIN) on June 6, 2016, and annual harvest specifications were provided from Pacific Fishery Management Council (PFMC) staff and National Marine Fisheries Service (NMFS), West Coast Region (WCR) staff. R code for the plots was provided by Nick Tolimieri of Conservation Biology Division (CB), Northwest Fishery Science Center (NWFSC), as contributed to Lewin et al. 2015.

Understanding the plots

The time-series plots (Figures 1 through 8) show levels of annual landings, harvest specifications, and attainment (top, middle, and bottom panels respectively) for each species with icons representing two relative statistics on the right hand side: the arrow in top right indicates whether the trend of the last five-years is positive (arrow up), negative (arrow down) or unchanged (arrow sideways); this indicates the trend since 2011, under IFQ management. Figure i. shows the key for icons, lines and shading used in the time series plots.

An indication of the short term trend (2011-2015) is given at the bottom right of each panel; the sign at the bottom right of each plot shows whether the mean of the last five years is greater than (a plus sign), less than (a negative sign) or within one standard deviation of the mean (a large dot) of the entire time series.

On each panel, the red solid line indicates the metric itself (landings, harvest specification or attainment), the green box on the right side shows the most recent five years, the green dotted line indicates the mean of the time series, and the green solid lines above and below the mean indicate plus and minus one standard deviation of the mean, which in the case of normally distributed data, captures the middle two thirds of the distribution. This gives an indication of the variance, and location for the bulk of the data over time.

The quad plots summarize all species on one plot for each metric (three plots total), and show the trend over the last five years, versus the long term. As an example, Figure 9.A. shows that most of the species cluster together in terms of landings trends, within one standard deviation of the mean, for both long and short term, but petrale sole is an outlier, in that landings have dramatically increased over the most recent five years, following the rebuilding trajectory, and the ACL of this highly attained stock.

Some important management changes along the time series

When interpreting this information, it is important to note that a number of important management changes have occurred along the time series. Stock changes between overfished and rebuilt status affected specifications and harvest rates of the species explored here, either directly as targets or indirectly as constraining bycatch species. For instance, the canary rockfish stock was declared overfished in January of 2000, and a conspicuous immediate, long-term drop in landings, harvest specifications, and attainment can be clearly seen in Figure 6. The 2015 canary rockfish assessment revealed that the stock has rebuilt, and harvest specifications are set to increase in the 2017-2018 cycle. Yelloweye rockfish, although not shown here, was declared overfished in 2002. Widow rockfish was declared overfished in 2001, and rebuilt recently in 2013. Together, these species posed substantial constraints to landings of many important targets in the trawl and other groundfish fisheries from the early 2000s forward, including Dover sole (shelf access), lingcod, yellowtail rockfish, and others. Lingcod was also declared overfished in 1999 and subsequently was rebuilt by 2005. Petrale sole was declared overfished in 2010 and was estimated to be rebuilt in 2015. Rockfish conservation areas (RCAs) were put in place beginning in 2002, in order to decrease catch of rebuilding species, which further reduced opportunity for many shelf and shelf-slope target species. The vessel buyback program, initiated in 2003, reduced groundfish fishery capacity by more than 30 percent. The West Coast IFQ Program was implemented in January

2011, which transitioned the trawl fishery out of trip limit management and into annual quotas for nearly 30 species and complexes.

Summaries by species

Dover sole shows a highly variable landings history over the time series since 1995, with its peak landings in 1996 at 12,000 mt, and a second peak, nearly as high in 2009. The 1996 peak includes an unusually high proportion of nominal Dover sole in the estimate for that year, which adds uncertainty. Despite the high variability, the long term average trend in landings has been relatively flat overall, as well as that of the past five years. At the same time, the trend in the ACL has been upward, including a sharp increase in 2015, approximately doubling it. The long term attainment trend has been slightly downward (although within one S.D.), mirroring the upward trend in ACL. Decreasing attainment has been due in large part to the steadily increasing ACL (with the largest increase in 2015), in addition to the shallow decreasing recent landings trends (Figure 1); this dependency has been especially obvious since 2009.

Lingcod had its highest landings over the series in 1995, 1996 and 1997, peaking also in 1996 at nearly 1,200 mt. Landings fell sharply in 1998, following declaration of overfished status, but did not recover to former levels after the stock was rebuilt in 2005, and the OY dramatically increased. This may be due to both constraints of overfished shelf species like canary and yelloweye rockfish, which persisted through 2015 in the case of canary (yelloweye is still under a rebuilding plan), and establishment of RCAs, which also may decrease opportunity for some species. Attainment has remained low since the first precautionary catch restrictions were put in place, just before the species was declared overfished (Figure 2).

Arrowtooth flounder, like Dover sole, shows a variable history of landings, harvest specifications and attainment. There are two peaks in landings, one in 1999 (5,200 mt) and another in 2009 (3,800 mt); the lowest annual landings were in 2002, at 840 mt. The OY and ACL were highest in a stretch between 2009 and 2012, where they ranged between 11,000 and 15,000 mt, but have otherwise hovered between 5,000 and 6,000 mt. Attainment has fluctuated widely, depending on both landings and harvest specifications, with little covariation between the two (Figure 3). Attainment is up somewhat short term, although the recent decreasing trend in ACL is largely responsible.

English sole landings and attainment has been consistently low, despite fluctuations in harvest specifications, including a peak ACL of nearly 20,000 mt in 2011 (Figure 4). Landings dropped below 400mt in 2008, with attainment at less than 5 percent of the OY/ACL, and have remained below that level since. Aside from the peak OY in 2011, landings, ACL and attainment have remained relatively flat overall since 2008 (Figure 4).

Widow rockfish landings, OY and attainment were consistently high until the stock was declared overfished in 2001. Since then all three metrics remained near the minimum of the series until recently, when they began to slowly climb again in 2013-2015 (Figure 5).

Canary rockfish landings averaged approximately 800mt from 1995 until 1999, after which they dropped precipitously upon the stock being declared overfished in 2000. Landings have remained lower than 50mt (often less than 10mt) through 2015. The 2015 assessment found the stock to be rebuilt, and the range of preliminary 2017-18 harvest specifications reflect this, potentially leading

to dramatically larger values of the ACL and trawl allocation, which is anticipated to create additional opportunities to many shelf targets for which canary is currently a bycatch constraint (Figure 6).

Petrale sole and sablefish north of 36° N. latitude were both included as attainment "positive controls", as they have shown consistently high attainment rates under the IFQ program (excluding a dip in 2010 during rebuilding for petrale sole). Attainment rates of the trawl allocation have consistently been between 90 and 100 percent for both stocks under IFQ, while attainment by the IFQ sector as a portion of the ACL has been between 40 and 45 percent for northern sablefish, and between 80 and 90 percent of the ACL for petrale sole, according to different sector-specific allocation rules for each stock (Figures 7 and 8).

Historically, petrale sole attainment by the LE trawl sector under trip limit management was consistently high (highly trawl dominant), staying between 70 and 98 percent of the OY/HG - aside from 2010 when it was declared overfished. Landings under IFQ closely followed the ACL, which jumped in 2013 following the ACL (Figure 7). The stock was declared rebuilt in 2015.

Sablefish, which has been the most valuable species in the fishery in terms of ex-vessel price, is highly sought after using both trawl and fixed gear sectors, has historically shown a highly variable time series of landings, OY and attainment. Between 1995 and 2010, attainment of the OY or HG ranged between 30 and 50 percent. Between 2011 and 2015, attainment under IFQ has been more consistent, at between 41 and 45 percent of the ACL (Figure 8).

Key for time series plots

See Figure i. below for description of the icons, color coding, etc. used in the time series plots, Figures 1 through 8.

Multi-species summary plots

Figures 9.A. through 9.C. summarize both short and long term trends for all eight species together on three plots, one for each metric (landings, harvest specification and attainment). Short term trend is shown on the x-axis, while long term change is shown on the y-axis.

Figure 9.A. illustrates that there have not been extreme trends for these species in in terms of sector landings, except for petrale sole, which has shown a dramatic upswing in landings over the past five years, while this highly attained species has followed the increasing ACL as the stock rebuilds.

Figure 9.B. shows that although the long term trend in harvest specifications has not varied substantially (y-axis), but has varied substantially in the short term (over the past five years) among the species shown here. The ACL has recently increased greatly for petrale sole, and for Dover sole, while the English sole and arrowtooth flounder ACLs have decreased markedly over the past five years.

Figure 9.C. shows that although the ACL has changed substantially for those four stocks, their attainment has changed less over the short term. It also reflects that petrale sole has always been highly attained. It reflects that Dover sole attainment has decreased somewhat short-term (due in large part to a dramatic increase in the 2015 ACL), and is markedly down over the long term; y-

axis (see “Summaries by Species” section, page 3). Arrowtooth flounder attainment is up somewhat short term (although the recent decreasing trend in ACL is largely responsible), and English sole shows little change in attainment from the short term average.

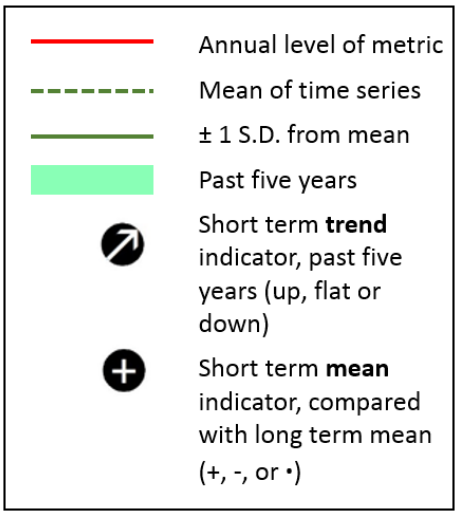

Figure i. Key for lines, shading and icons used in time series plots.

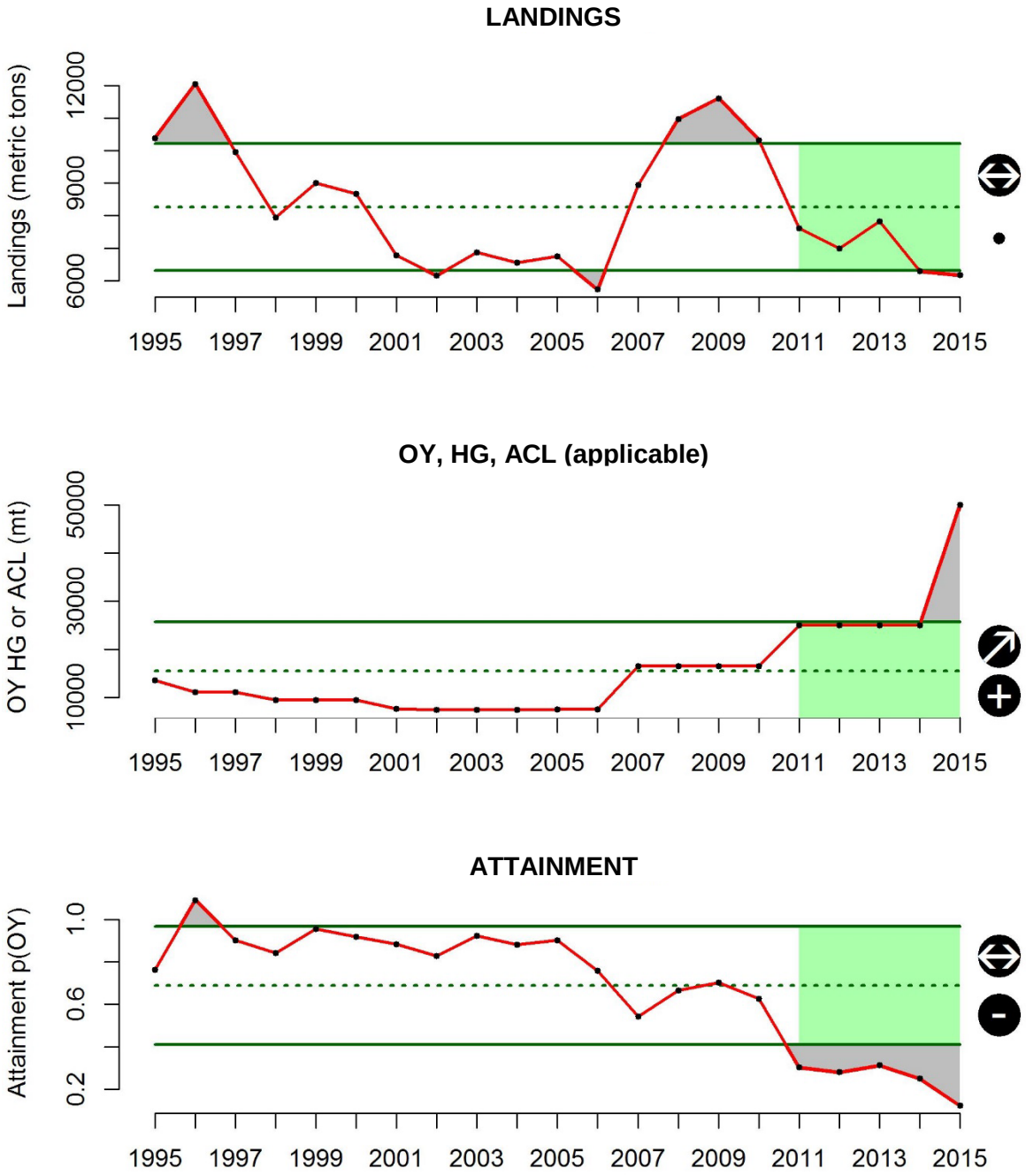

Figure 1. Time-series of **Dover sole** landings (top) in shorebased LE trawl 1995-2010, and IFQ 2011-2015, year-relevant harvest specification (middle: OY, HG, or ACL), and attainment of harvest specification (bottom: proportion). Two relative statistics appear on the right hand side: the arrow in top right indicates whether the trend of the last five-years is positive (arrow up), negative (arrow down) or unchanged (arrow sideways); the sign at the bottom right shows whether the mean of the last five years is greater than (a plus sign), less than (a negative sign) or within 1SD of the mean (a large dot) of the entire time series.

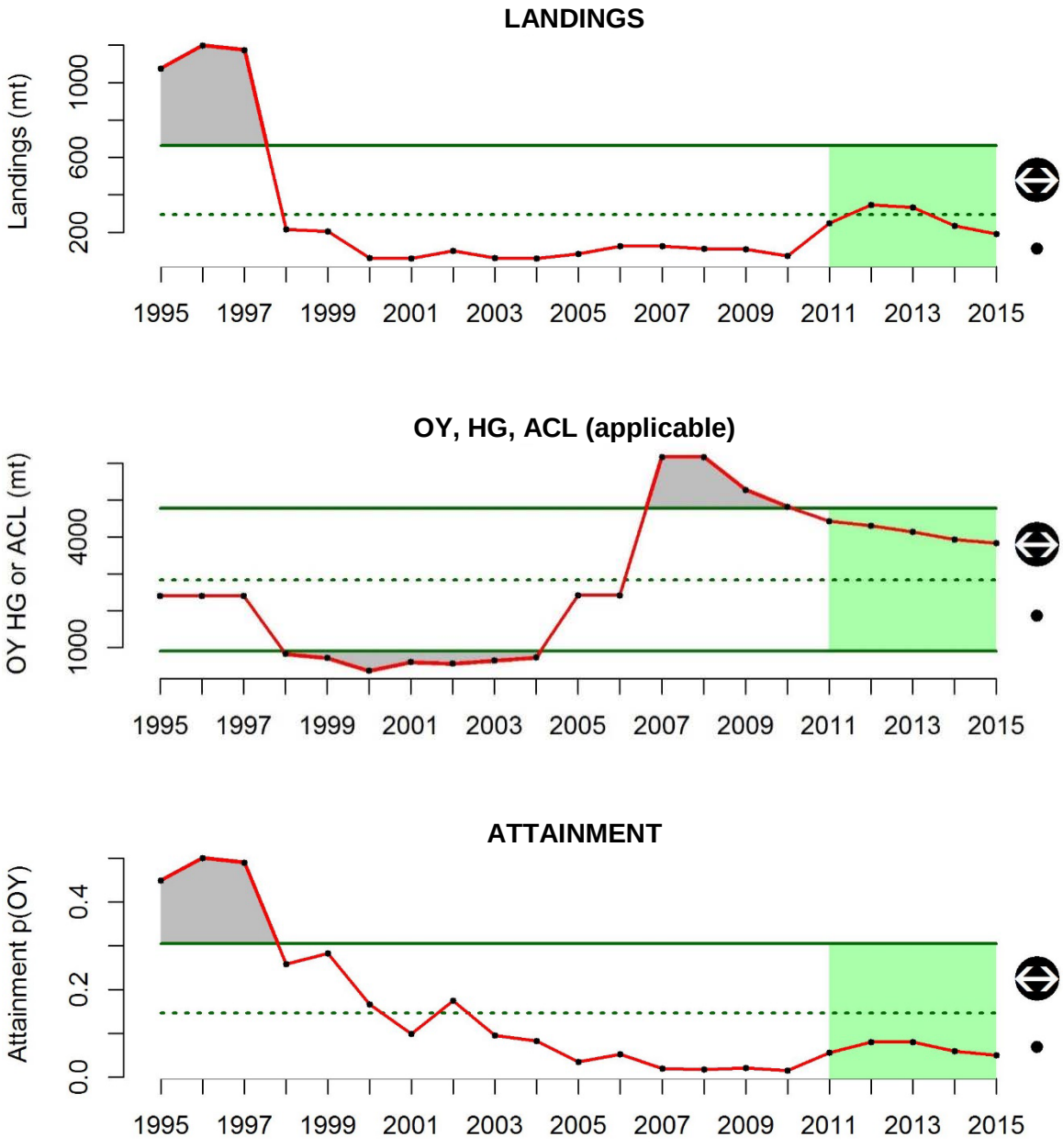

Figure 2. Time-series of **lingcod** landings (top) in shorebased LE trawl 1995-2010, and IFQ 2011-2015, year-relevant harvest specification (middle: OY, HG, or ACL), and attainment of harvest specification (bottom: proportion). Two relative statistics appear on the right hand side: the arrow in top right indicates whether the trend of the last five-years is positive (arrow up), negative (arrow down) or unchanged (arrow sideways); the sign at the bottom right shows whether the mean of the last five years is greater than (a plus sign), less than (a negative sign) or within 1SD of the mean (a large dot) of the entire time series.

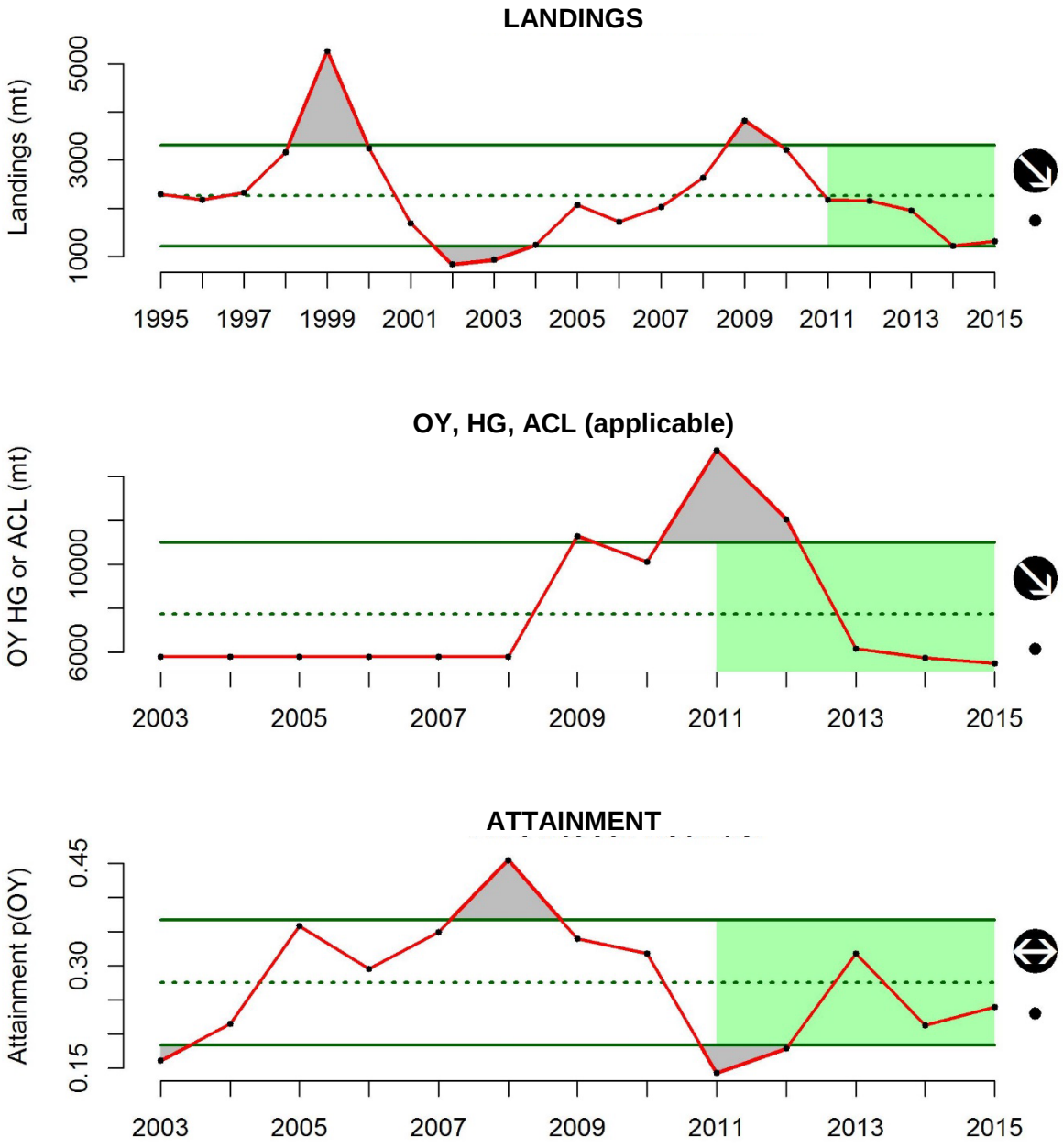

Figure 3. Time-series of **arrowtooth flounder** landings (top) in shorebased LE trawl 1995-2010, and IFQ 2011-2015, year-relevant harvest specification (middle: OY, HG, or ACL), and attainment of harvest specification (bottom: proportion). Two relative statistics appear on the right hand side: the arrow in top right indicates whether the trend of the last five-years is positive (arrow up), negative (arrow down) or unchanged (arrow sideways); the sign at the bottom right shows whether the mean of the last five years is greater than (a plus sign), less than (a negative sign) or within 1SD of the mean (a large dot) of the entire time series.

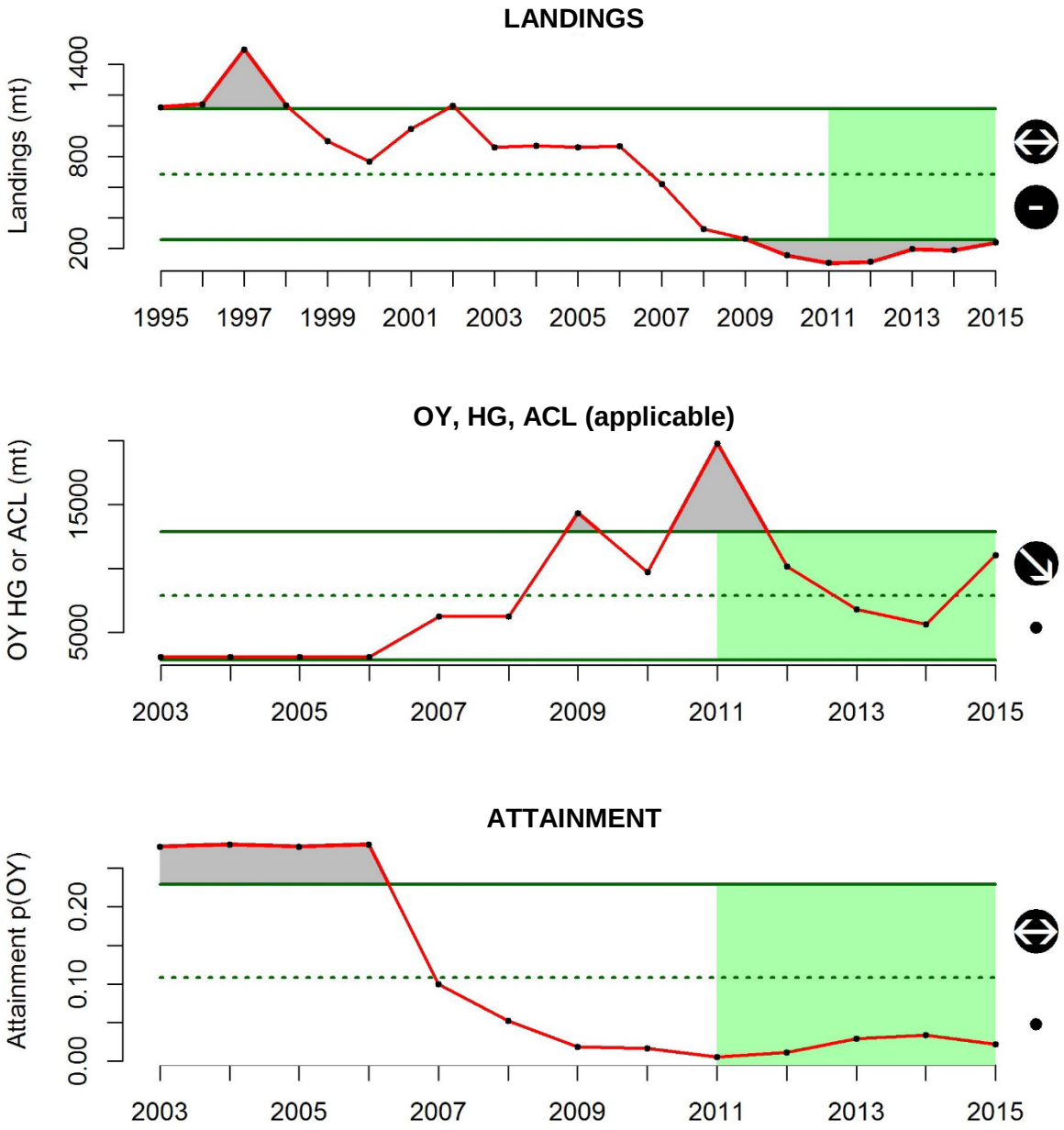

Figure 4. Time-series of **English sole** landings (top) in shorebased LE trawl 1995-2010, and IFQ 2011-2015, year-relevant harvest specification (middle: OY, HG, or ACL), and attainment of harvest specification (bottom: proportion). Two relative statistics appear on the right hand side: the arrow in top right indicates whether the trend of the last five-years is positive (arrow up), negative (arrow down) or unchanged (arrow sideways); the sign at the bottom right shows whether the mean of the last five years is greater than (a plus sign), less than (a negative sign) or within 1SD of the mean (a large dot) of the entire time series.

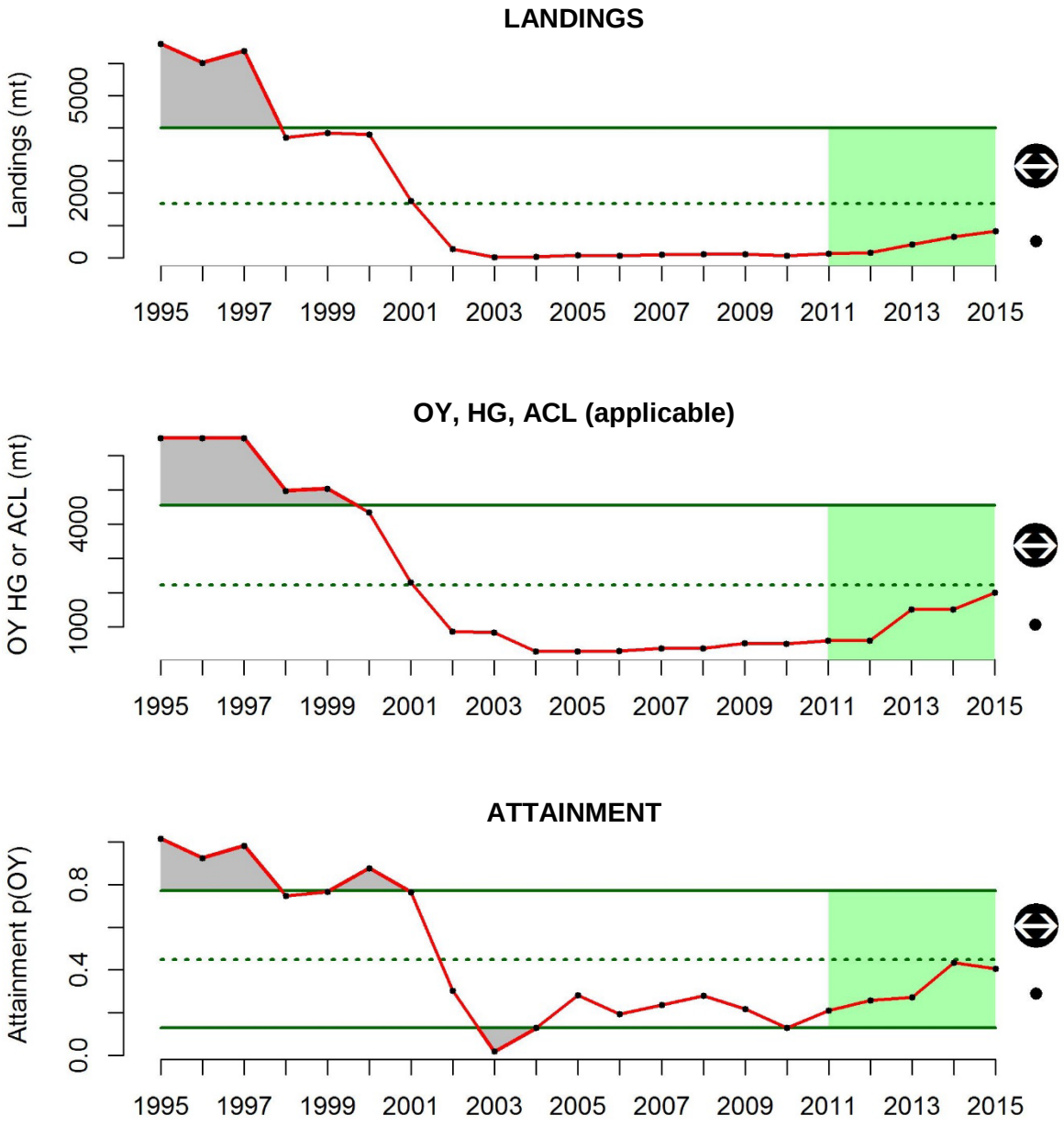

Figure 5. Time-series of **widow rockfish** landings (top) in shorebased LE trawl 1995-2010, and IFQ 2011-2015, year-relevant harvest specification (middle: OY, HG, or ACL), and attainment of harvest specification (bottom: proportion). Two relative statistics appear on the right hand side: the arrow in top right indicates whether the trend of the last five-years is positive (arrow up), negative (arrow down) or unchanged (arrow sideways); the sign at the bottom right shows whether the mean of the last five years is greater than (a plus sign), less than (a negative sign) or within 1SD of the mean (a large dot) of the entire time series.

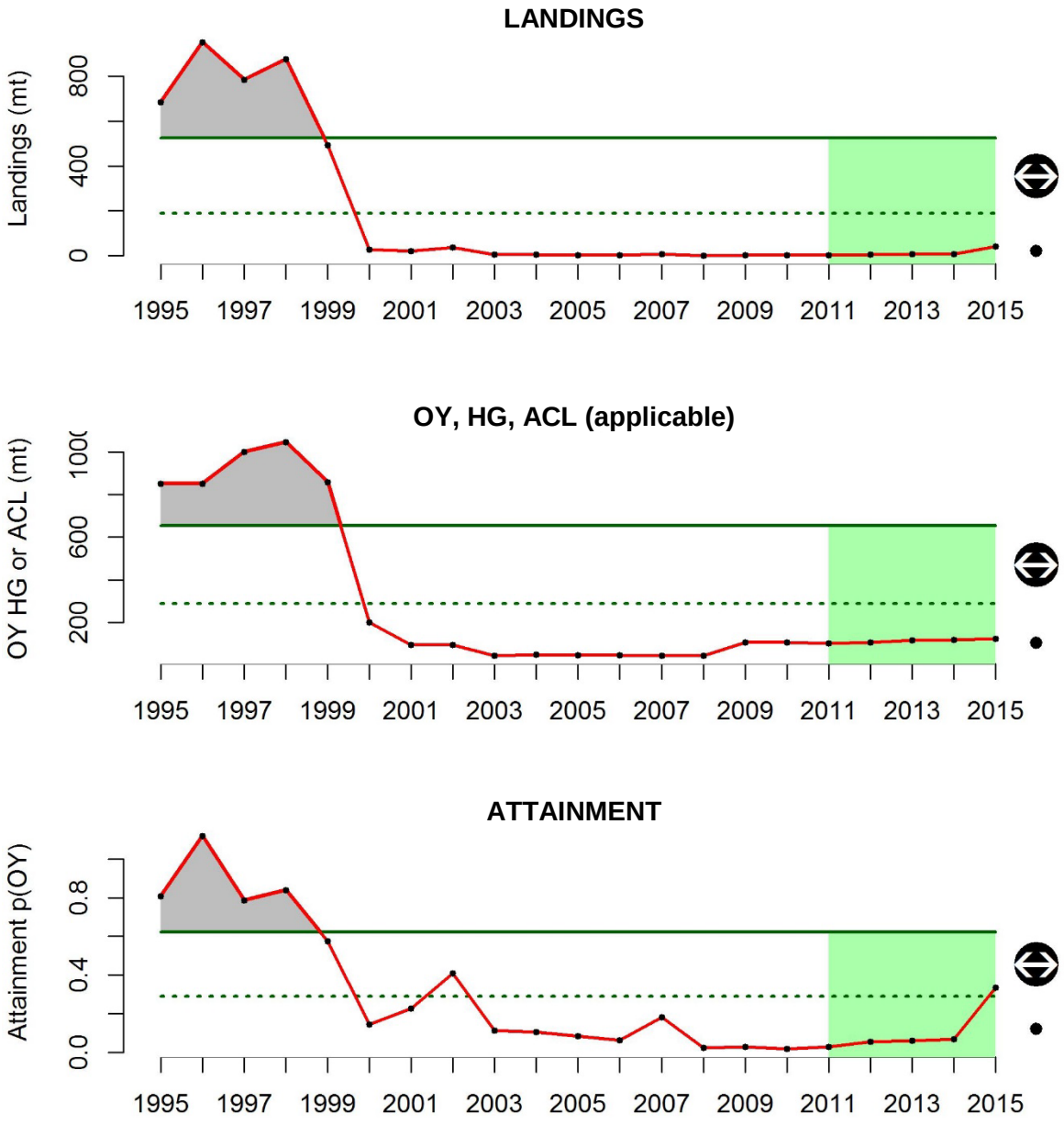

Figure 6. Time-series of **canary rockfish** landings (top) in shorebased LE trawl 1995-2010, and IFQ 2011-2015, year-relevant harvest specification (middle: OY, HG, or ACL), and attainment of harvest specification (bottom: proportion). Two relative statistics appear on the right hand side: the arrow in top right indicates whether the trend of the last five-years is positive (arrow up), negative (arrow down) or unchanged (arrow sideways); the sign at the bottom right shows whether the mean of the last five years is greater than (a plus sign), less than (a negative sign) or within 1SD of the mean (a large dot) of the entire time series.

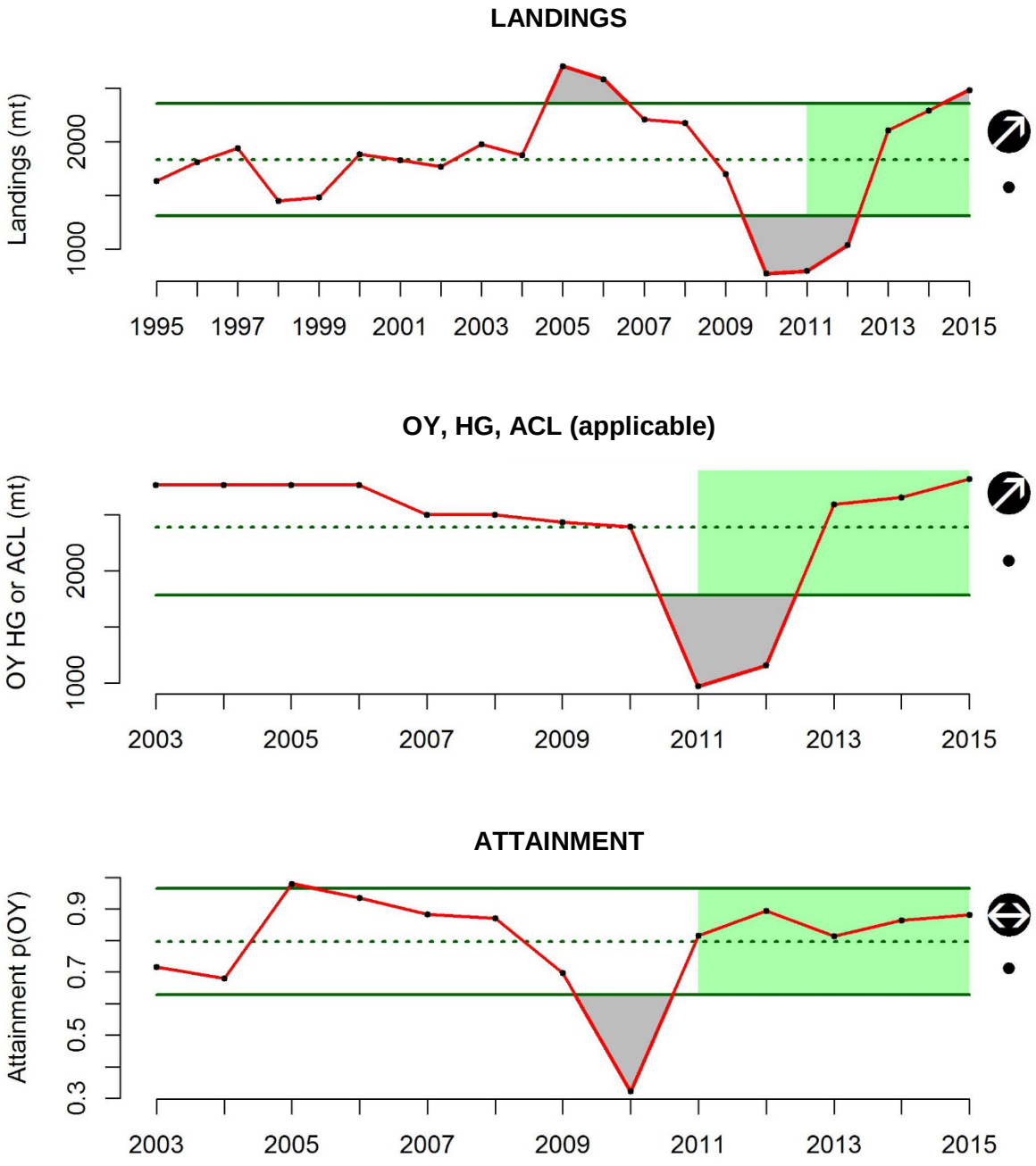

Figure 7. Time-series of **petrale sole** landings (top) in shorebased LE trawl 1995-2010, and IFQ 2011-2015, year-relevant harvest specification (middle: OY, HG, or ACL), and attainment of harvest specification (bottom: proportion). Two relative statistics appear on the right hand side: the arrow in top right indicates whether the trend of the last five-years is positive (arrow up), negative (arrow down) or unchanged (arrow sideways); the sign at the bottom right shows whether the mean of the last five years is greater than (a plus sign), less than (a negative sign) or within 1SD of the mean (a large dot) of the entire time series.

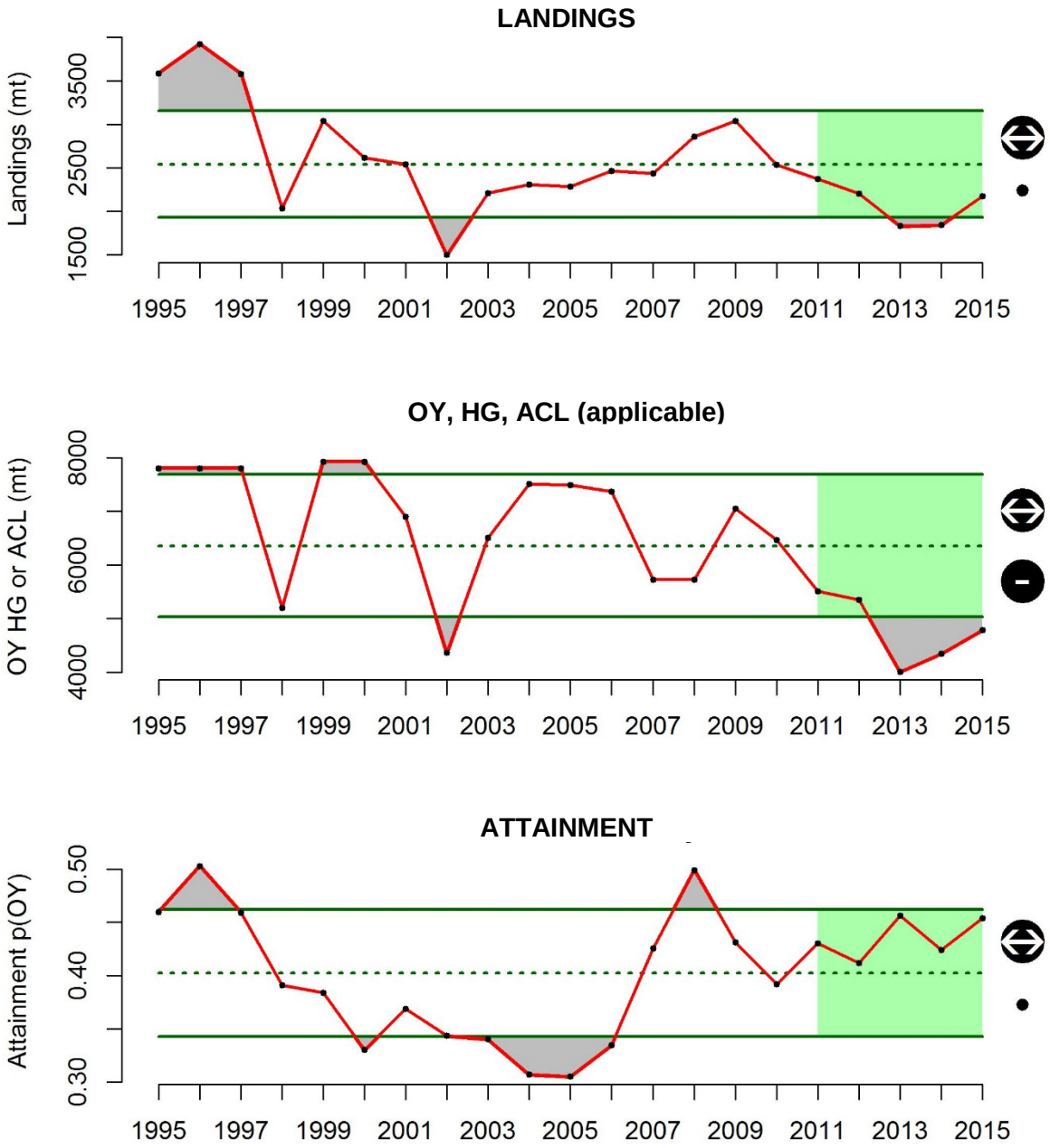

Figure 8. Time-series of landings for **sablefish, north of 36° N. latitude** (top) in shorebased LE trawl 1995-2010, and IFQ 2011-2015, year-relevant harvest specification (middle: OY, HG, or ACL), and attainment of harvest specification (bottom: proportion). Two relative statistics appear on the right hand side: the arrow in top right indicates whether the trend of the last five-years is positive (arrow up), negative (arrow down) or unchanged (arrow sideways); the sign at the bottom right shows whether the mean of the last five years is greater than (a plus sign), less than (a negative sign) or within 1SD of the mean (a large dot) of the entire time series.

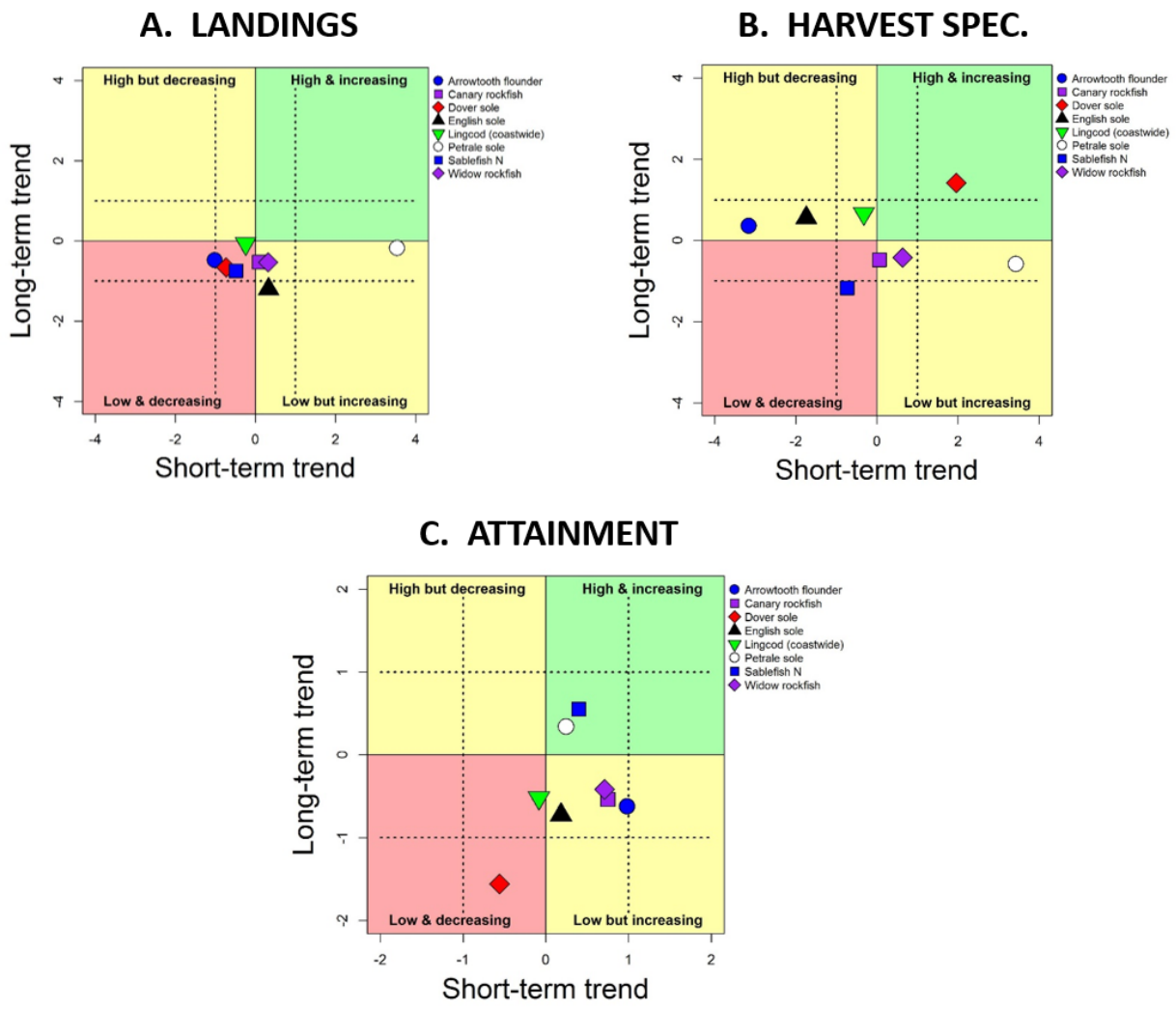

Figure 9. Quad plots showing short- versus long-term trends in A. landings, B. harvest specifications (OY, HG, or ACL, as appropriate by year), and C. attainment of harvest specification, for different IFQ species. **The short-term trend indicates the trend over the last five years of the landings, while the long-term trend indicates the difference between the long-term mean and the mean of the last five years.** The solid vertical and horizontal lines at the center of each square represent the mean of the time series, the dotted lines represent ± 1SD.

References

Levin, P. S., B. K. Wells, M. B. Sheer. (Eds.) 2015. California Current Integrated Ecosystem Assessment: Phase II.

PFMC. 2015. Status of the Pacific Coast groundfish fishery through 2015 and recommended acceptable biological catches for 2004 (Stock Assessment and Fishery Evaluation). Pacific Fishery Management Council, Portland, OR.