

Economic Performance Metrics for the West Coast Groundfish Trawl Catch Share Program

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1 Introduction

The West Coast Groundfish Trawl Catch Share Program was instituted in 2011 with a variety of economic goals: to provide for a viable, profitable, and efficient groundfish fishery; increase operational flexibility; minimize adverse effects on fishing communities and other fisheries to the extent practical; promote measurable economic and employment benefits through the seafood catching, processing, distribution, and support sectors of the industry; provide quality product for the consumer; and, increase safety in the fishery. With it, a mandatory Economic Data Collection (EDC) program was established at the Northwest Fisheries Science Center (NWFSC) to provide information to evaluate progress toward these goals. In this report, EDC and supplementary data are used to develop and report a set of economic metrics to measure the economic performance of the fishery.

The metrics should not be interpreted as causal (i.e., catch shares caused X to change)¹, directional (e.g.,

¹Statistical causality can only be established with a much more in-depth research design [1].

“up is ‘good’, down is ‘bad’”), nor normative (i.e., a particular result is “good” or “bad”). They are intended to facilitate the examination of changes occurring in the fishery, and to motivate more in-depth research.

Many of the metrics presented here echo the performance metrics compiled for catch share fisheries across the country by the National Oceanic and Atmospheric Administration (NOAA) in the The Economic Performance of U.S. Catch Share Programs report [2].² The metrics provided here are intended to provide additional information about this particular fishery, divide aggregate data along useful attributes, and highlight characteristics and trends that are particularly cogent for the West Coast Groundfish limited entry trawl fishery. In addition, the EDC program provides data that are unavailable in some other regions, which allows us to calculate metrics that are not able to be included in the national level report (The Economic Performance of U.S. Catch Share Programs).

The metrics will be updated annually as new EDC data become available. In addition, users of the NWFSC’s Fisheries Economics Explorer (FISHEyE) application³ will be able to aggregate, disaggregate, and explore these metrics interactively.

2 Choice of metrics

An “economic indicator” is a statistic used to analyze past economic performance or predict future economic performance. Economic indicators are often used to describe characteristics of a broader economic system. On their own, metrics such as jobless claims for unemployment insurance, manufacturer orders, building permits, or interest rates give specific information about particular trends, but taken together, they help portray a broader depiction of the overall performance of the economy.

Similarly, the metrics we present in this report measure particular aspects of the economic performance of the West Coast groundfish limited entry trawl fishery. Interpreted together, they help to detect changes in trends and processes, and develop a narrative about the overall performance of the fishery and progress toward the goals of the catch share program. With these metrics, we provide a basis for understanding changes that have occurred in terms of their effect on the following individuals, entities, and economic measures:

- Vessel owners
- Vessel crew members
- Processing employees

²The national metrics created by NOAA Fisheries’ Office of Science and Technology were chosen to represent factors that tend to change under catch share management systems using data that are available in all of the fifteen U.S. catch share fisheries included in the report. Because they were intended to apply to all catch share programs across the country, their scope is quite broad.

³FISHEyE website: <https://dataexplorer.northwestscience.fisheries.noaa.gov/fisheye/>

- Disparate effects among fishery participants
- Processing facilities
- Profitability
- Net economic benefits
- Efficiency
- Consolidation
- Participation
- Interaction with other fisheries and fishing sectors
- Regional economic impacts.

A wide variety of information is applicable to each general topic. However, a key goal of this document is to present a relatively concise set of indicators that represent the primary economic changes that may occur under the catch share program and for which data are available. They are not intended to be comprehensive [3].⁴ The metrics in this report were selected based on four criteria:

1. Theoretical significance
2. Relevance to management needs
3. Relevance to the fishery
4. Data availability

By following these four criteria, we developed a set of parallel indicators for each sector in the West Coast groundfish catch share program (catcher vessels, catcher-processors, motherships, and shorebased processors). These metrics are intended to provide accurate, understandable, and theoretically sound information that pertains to the topics listed above.

3 Types of metrics

The performance metrics for each sector are divided into four sub-sections: demographic indicators, vessel (or processor) average economic indicators, fleet-wide (or industry-wide) economic indicators, and regional economic impacts. Each is described below.

⁴A more comprehensive presentation of the EDC program and the data is available in the EDC reports [4, 5, 6, 7].

- **Demographic indicators** include characteristics of the vessels and processors (such as the average length of vessels in the fleet, their dependence on revenue from the catch share fishery, and average days at sea). Changes in the demographic metrics may indicate changes such as fleet consolidation, economic efficiency, productivity, specialization, or diversification.
- **Vessel (or processor) average economic indicators** show the average value of the metric across all participants, as well as the standard deviation. They can be thought of as representing a typical or average vessel in the fleet or processor in the industry, and the standard deviation is an indication of the variation within the groups.
- **Fleet-wide economic indicators** represent the total value generated by the fishery, and provide information about the performance of the fishery and the processing industry as a whole.
- **Social and regional metrics** describe the distribution of landings and processing across states and through a season, provide information about employment in the fishery, and present economic impacts that describe the total regional income and employment attributable to the catch share fishery on the West Coast.

Changes in the economic metrics may be indicative of changes in total allowable catch (TAC) of Pacific whiting, annual catch limits (ACLs) of non-whiting groundfish, quota utilization, fish or product prices, costs or cost structure, profitability, productivity, spatial distribution of landings, and diversification. Several of the metrics are also provided as rates. Rates can help decipher the drivers of important changes in the fishery. For example, revenue per crew day is a measure of worker productivity, while revenue per day of fishing is a measure of fishing productivity.

The West Coast Groundfish fishery includes vessels that mostly fish for Pacific whiting on the West Coast (including catcher vessels, catcher-processors, and motherships), and vessels that fish mostly for non-whiting groundfish species (catcher vessels only). The operational and physical characteristics of these vessels varies considerably, and thus effects of catch shares may be different. Pacific whiting is a high-volume target with relatively low ex-vessel price. When whiting and non-whiting vessels are combined, changes in the non-whiting group would be obscured by the volume of Pacific whiting landings.⁵ To capture the disparate effect across these groups, each metric is presented for the fleet as a whole (all vessels or processors), as well as separately for vessels (or processors) that fish for (or process) Pacific whiting, and those vessels that target non-whiting groundfish. There are several vessels that fish for both whiting and non-whiting, and these vessels are included in the “whiting vessels” category. Processors are categorized into mutually

⁵In addition, the catch limit for Pacific whiting has much more annual variation than catch limits for species targeted in the non-whiting groundfish sector.

exclusive groups as well. All processors that buy Pacific whiting also process non-whiting groundfish. Thus, we separate these processors (“whiting and non-whiting processors”) from those that exclusively process non-whiting groundfish (“non-whiting processors”). Separation allows the investigation of trends that are particular to each set of vessels or processors.⁶

4 Information presented in each metric

The EDC program began in 2011 with the collection of 2009 and 2010 data to provide two years of baseline data prior to the implementation of the catch share program. EDC data are collected annually, and currently include data through 2014. For these performance metrics, the EDC data are supplemented with data from three other sources: landings data (fish tickets),⁷ the at-sea hake observer program,⁸ and permit data.⁹

Each metric is presented for the time period 2004-2014 when data are available. Because EDC data collection began in 2009, metrics that require EDC data are only displayed for 2009-2014. There is a three-year lag for fully finalized EDC data, so data from the most recent displayed year (2014) should be considered preliminary.¹⁰ Additional years will be added as new EDC data become available.

The figure below depicts how to interpret the information provided in the graphs throughout the report. Black lines are for all the vessels (or processors) in the fleet (industry). Blue lines are for participants in the Pacific whiting category, and red lines are for participants in the non-whiting category. Several vessels fish for both Pacific whiting and for non-whiting groundfish. If a vessel participated in both, then it is included in the “Whiting vessels” category. This means that there are several vessels that fished for non-whiting groundfish that are not included in the “Non-whiting vessels” category, but are included in the “Whiting vessels” category. If, in a subsequent year, a vessel that participated in both fisheries stopped fishing for whiting, the vessel would move to the “Non-whiting vessels” category for that year.

The shaded areas indicate one standard deviation around the mean for the whiting and non-whiting categories. Standard deviations are not included for the “all vessels” category to maintain the readability of the figures. Standard deviations demonstrate the amount of variation among vessels (processors) in each

⁶The groups defined by this method of categorization are similar, but not identical, to the groups that would be created by categorizing vessels and processors by size, into “large” and “small” entities based on vessel length or vessel (processor) revenue.

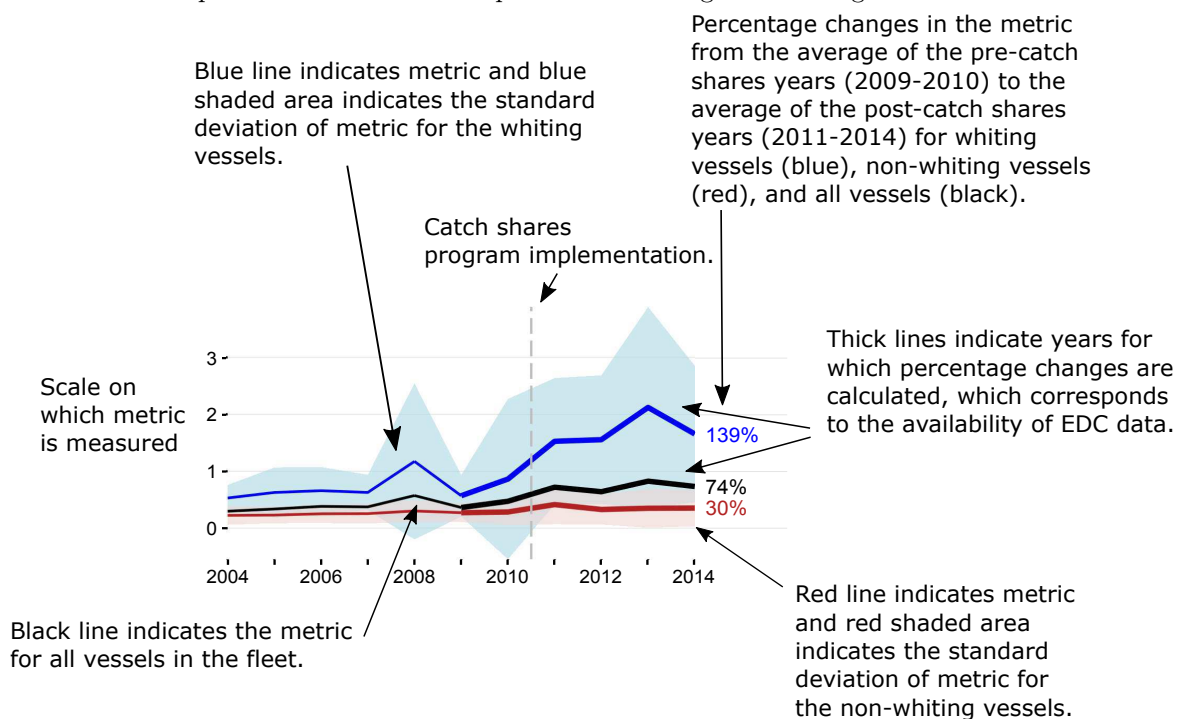
⁷Pacific Fisheries Information Network (PacFIN), Pacific States Marine Fisheries Commission, Portland, Oregon (www.psmfc.org).

⁸NPAC4900_SPCOMP table from Pacific Fisheries Information Network (PacFIN), Pacific States Marine Fisheries Commission, Portland, Oregon (www.psmfc.org).

⁹Pacific Coast Fisheries Permit System, West Coast Regional Office (https://www.webapps.nwfsc.noaa.gov/apex_ifq/f?p=112:23).

¹⁰EDC forms are submitted by September 1 each year for the previous fiscal year (FY2014 data are received in September of 2015), allowing companies to “close their books” and file taxes before completing their EDC forms. The QA/QC process requires approximately 6 months. This means that 2014 EDC data were available in March 2016; however, there is one additional complication. Participants submit data by fiscal year which varies by company and may not completely overlap by calendar year. Although the reports are released at a 2-year lag, the data are not considered completely finalized until the following year once the complete set of data have been received and processed. As a result, calendar year 2014 data are not completely finalized until Spring 2017.

sector. The percentages on each figure represent the percent change from the 2009-2010 average (pre-catch share data that correspond to the beginning of EDC data collection) to the 2011-2014 average (post-catch share data). The red, blue, and black lines are bolded to indicate the data that are included in the calculation of the percentage changes. The figures are blank prior to 2009 for metrics that require EDC data. A gray dashed line between 2010 and 2011 indicates the beginning of the catch share program. Definitions of each metric and their importance or rationale are provided to the right of each figure.



All dollar values are presented in real 2014 terms (adjusted for inflation using 2014 as the base year).

All figures will be available for customization, disaggregation, and exploration through the NWFSC's FISHEyE application in the future. At present, only metrics for the catcher vessels have been incorporated into FISHEyE.¹¹

¹¹FISHEyE website: <https://dataexplorer.northwestscience.fisheries.noaa.gov/fisheye/>

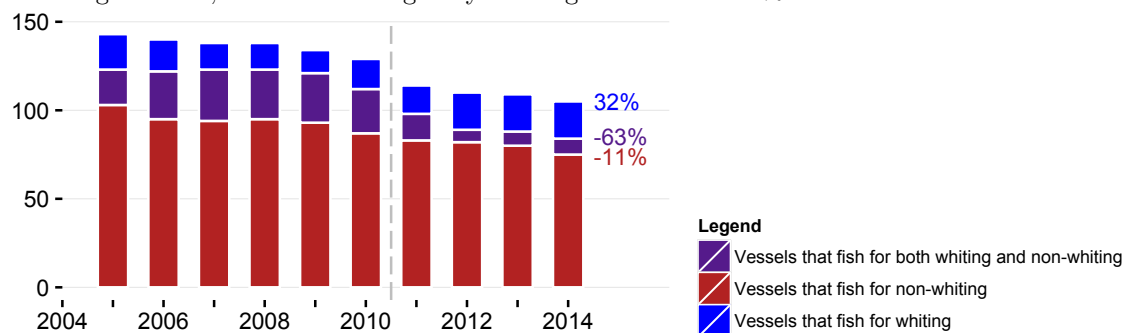
Part I

Catcher vessels

5 Demographic Indicators

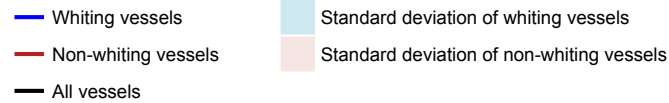
Quota is allocated for more than 30 species and species complexes as a part of the 2011 West Coast Groundfish Catch Share Program. Many participants in the program also participate in other fisheries such as Dungeness crab, shrimp, salmon, and tuna on the West Coast, and Walleye pollock in Alaska.

The number of vessels actively participating (i.e., had an active permit and non-zero revenue) in the fishery has been decreasing since 2005. The figure below shows the percentage changes from the 2009-2010 average to the 2011-2014 average, as well as the historical numbers. Red bars show the number of vessels participating exclusively in the non-whiting fishery, which has decreased by 11%. Blue bars show the number of vessels participating exclusively in the whiting fishery, which has increased by 32%. Effort by whiting vessels is strongly driven by the annual total allowable catch (TAC) of Pacific whiting; many of these vessels also fish for Walleye pollock in Alaska. If Pacific whiting TAC is low relative to pollock, some vessels may not fish on the West Coast at all. Purple bars show the number of vessels participating in both the whiting and non-whiting fisheries, which has changed by the largest amount: -63%.



Catch shares are generally expected to result in at least some fleet consolidation. This figure shows an additional effect: more vessels are specializing in either the whiting or non-whiting sector of the fishery. In the remainder of the report, vessels that participate in both sectors (the purple bars) are included in the “whiting vessels” category. When these two categories are combined, the number of catcher vessels participating in the whiting fishery has decreased by 29%. Note that this categorization contributes to some of the changes in the metrics included in the rest of the report.

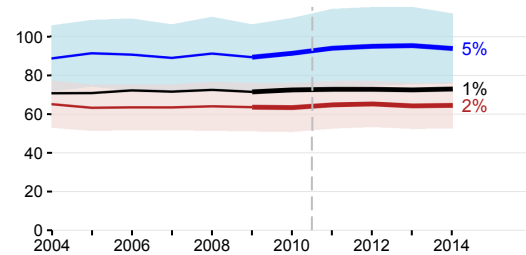
Legend



Metric and Definition

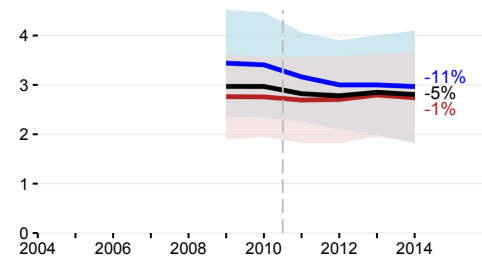
Length of vessels (ft)

The average length of vessels reflects the mix of active participants in the fishery in each year.



Fishery participation

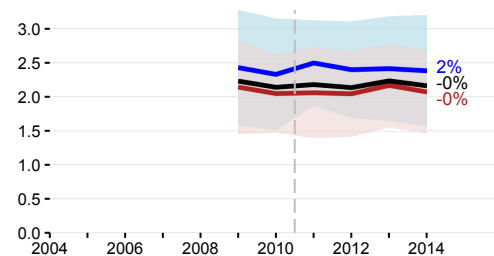
Average count of fisheries¹² that vessels participated in. Changes may indicate specialization or diversification.



Exponential Shannon Index (ESI)

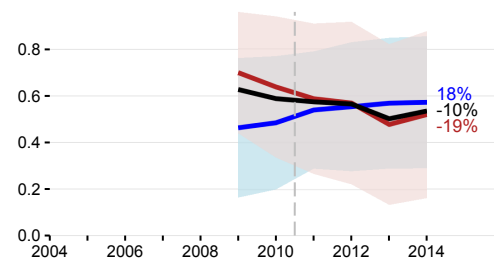
Measures the income diversification of a vessel across revenue sources. A larger number corresponds to increased diversification. Changes may indicate specialization or diversification.

$ESI = -exp \left[\sum_{i=1}^{15} p_i \ln(p_i) \right]$ where p_i is the proportion of revenue from fishery i .



Proportion of revenue from catch share fishery

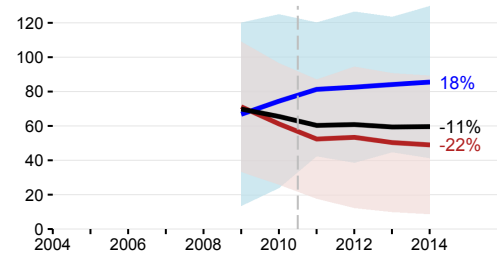
Measures how reliant vessels are on revenue from the limited entry/catch shares fishery.



¹²The EDC Program reports [5] break fleet activities into the following “fisheries”: at-sea whiting, shoreside whiting, Dover sole-Thornyhead-Sablefish (DTS) trawl with trawl endorsement, groundfish fixed gear with fixed gear endorsement, groundfish fixed gear with trawl endorsement, non-whiting non-DTS trawl with trawl endorsement, non-whiting midwater trawl, crab, shrimp, “other” West Coast fisheries, and Alaska fisheries. The fisheries are defined at the trip level by the gear, location, permit, and primary revenue source. In this report, metrics such as the “number of fisheries participated in” are measured at this level.

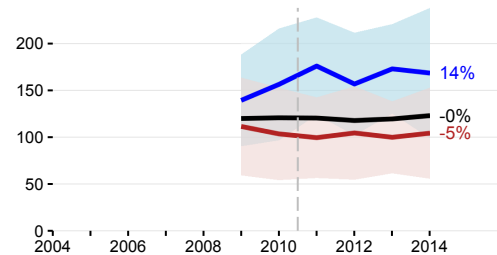
Days at sea in catch share fishery

The average number of days at sea in the limited entry trawl or catch share fishery may indicate changes in specialization, efficiency, or consolidation.



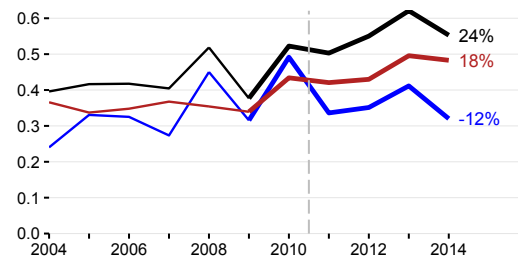
Total days at sea in all fisheries

This metric can be compared to the average days at sea in the catch share fishery to help determine the extent to which vessels are changing their patterns of participation in the catch shares fishery and overall.



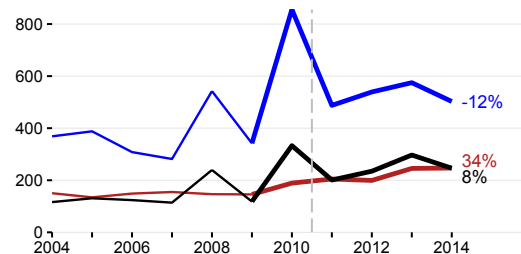
Gini coefficient of catch share revenue

Measures the degree of catch share revenue concentration among vessels. A value of zero would represent all vessels earning the same revenue, and a value of one would represent one vessel earning all of the revenue. The value of the Gini coefficient can be affected by fleet consolidation and specialization.



Herfindahl- Hirschman Index (HHI)

The HHI is a measure of market concentration. It is calculated as the sum of the squares of the market shares, defined here by the share of catch share revenues earned by each vessel. Smaller numbers indicate lower market concentration.



The total number of vessels fishing in the catch share fishery has decreased by 17% from the 2009-2010 average to the 2011-2014 average. The average length of whiting vessels increased by 5%, likely driven by the decrease in the number of vessels fishing for both whiting and non-whiting, which tend to be smaller. Overall, the average length of vessels in the fishery remained relatively constant.

The average number of days at sea in the whiting fishery increased by 18%. This was primarily driven by the decrease in the number of vessels fishing for both whiting and non-whiting. Vessels that specialize in the whiting fishery spend more days at sea in the whiting fishery, on average, than vessels that do both. Whiting vessels are participating in 11% fewer other fisheries, and earning 18% more of their total revenue from the West Coast catch share fishery than they did prior to the implementation of the catch share program.

The number of vessels fishing exclusively in the non-whiting sector has decreased by 11%. While the average number of fisheries they participate in has stayed the same, the percent of total revenue earned from the catch share fishery has decreased by 19%. For the non-whiting vessels, average days at sea in the catch share fishery has decreased by 22%, and average total days at sea (in all fisheries) has decreased by 5%.

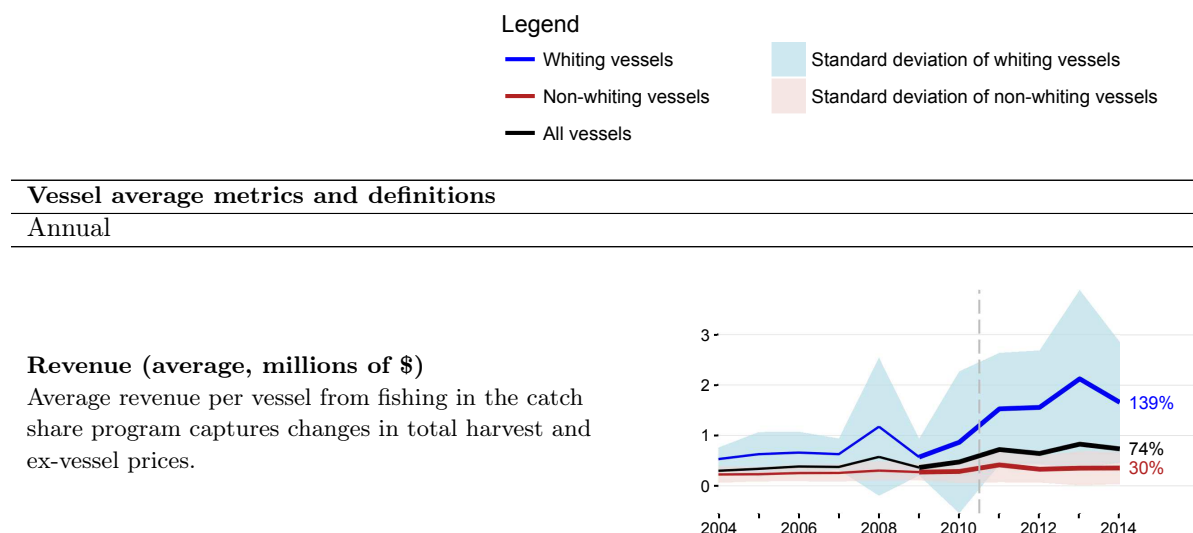
Despite these changes, the exponential Shannon Index, which measures income diversification across revenue sources for a vessel, shows almost no change.

The Gini coefficient of catch share revenue measures the degree of revenue concentration among vessels. In the whiting fleet, the Gini coefficient has decreased by 12%, indicating a decrease in revenue concentration. For the non-whiting vessels, the Gini coefficient has increased by 18%, indicating an increase in revenue concentration. Over all catcher vessels in the catch share fishery, the Gini coefficient has increased by 24%, indicating primarily an increase in revenue of the whiting vessels relative to the non-whiting vessels.

The Herfindahl-Hirschman Index (HHI) is similar to the Gini coefficient in that it measure the concentration of revenue among vessels, which is why the trends are similar. The HHI also has the capacity to account for ownership changes. Vessel ownership information will be incorporated into the index at a later date.

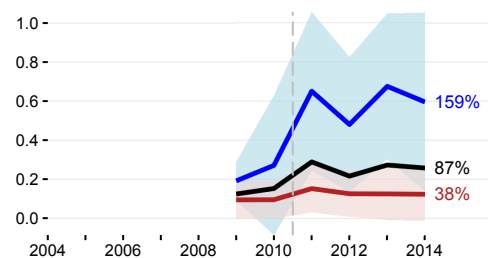
6 Economic Indicators

6.1 Vessel Averages

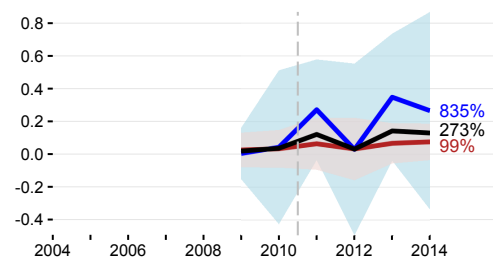


Variable cost net revenue (average, millions of \$)

Average variable cost net revenue is revenue minus variable costs (costs that vary with the level of participation, such as crew, fuel, buyback fees, observers, and other variable costs). Average variable cost net revenue is a measure of the average vessel's operating profit.

**Total cost net revenue (average, millions of \$)**

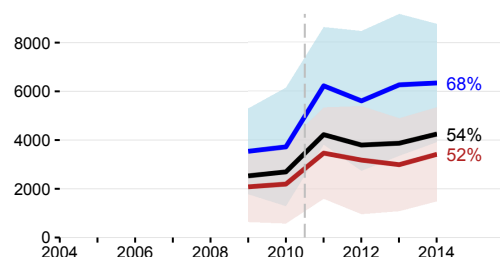
Average total cost net revenue is revenue minus variable and fixed costs (costs that do not vary with the level of participation, such as equipment and gear purchases). Total cost net revenue is a longer-term measure of profitability. In any given year, a vessel may have a large fixed cost expense (such as a new engine), which may lead to negative or unusually low total cost net revenue.



Per crew-day

Revenue per crew day (average \$)

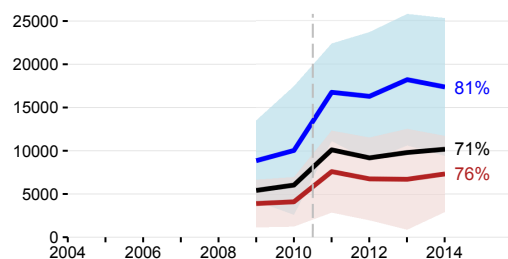
Average revenue per crew day (revenue divided crew day, where crew days are calculated as days at sea multiplied by number of crew per vessel) shows the average productivity (in terms of revenue generation) of a crew member.



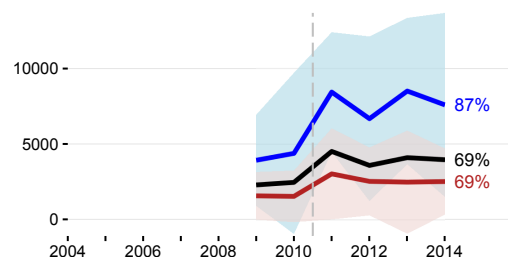
Per day of fishing in the catch share fishery

Revenue per day (average \$)

Average revenue per day from fishing in the catch share fishery. Revenue per day captures average gross earnings from a day of fishing in the catch share fishery.

**Variable cost net revenue per day (average \$)**

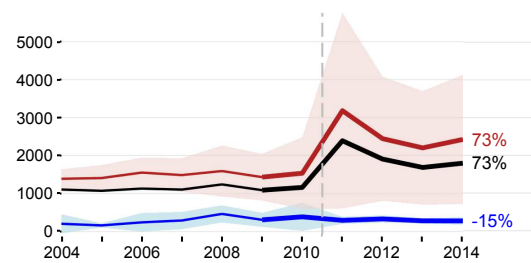
Average variable cost net revenue per day is revenue minus variable costs per day of fishing associated with the catch share program. It is a measure of the average daily operating profit of the average vessel.



Per metric ton of landings in the catch share fishery

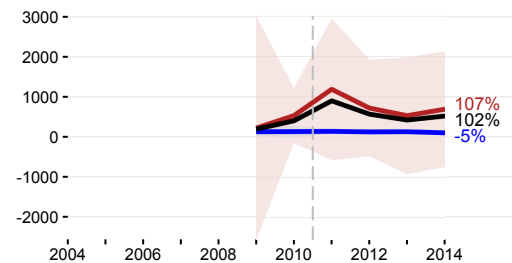
Revenue per ton (average \$)

Average revenue per metric ton of fish landed associated with the catch share program is analogous to an average price index (over all species caught).



Variable cost net revenue per ton (average \$)

Average variable cost net revenue per metric ton is revenue minus variable costs per pound of fish landed associated with the catch share program. Average variable cost net revenue per metric ton is analogous to per-ton operating profit margin for the average vessel, and is representative of the value of quota.



Average revenue in the catch share fishery is the average gross income received from fish caught in the catch share fishery. Changes in average revenue are driven by changes in TAC and ACLs and ex-vessel prices, and to some extent, the distribution of revenues among vessels. Average revenue, average variable cost net revenue (revenue minus variable costs), and average total cost net revenue (revenue minus variable costs and fixed costs) have increased for both categories of vessels, and for the fleet as a whole.¹³ Average total cost net revenue is much more variable because large fixed costs that occur intermittently, such as engine replacement, are included.

The average revenue per crew day has increased for each category and the fleet as a whole, although it has increased by the greatest amount in the whiting fishery (by 68%, compared to 52% in the non-whiting fishery). This means that for the average vessel, one crew-day has become more productive in terms of revenue generation.

Average revenue and average variable cost net revenue are calculated per day of fishing in the catch share fishery. Whiting vessels earn substantially more revenue and variable cost net revenue per day than non-whiting vessels, and the rate of increase is higher for whiting vessels.

These measures are also calculated per metric ton of landings. Average revenue per ton of catch is analogous to an average price index over all species caught. Average revenue per ton has decreased by 15% for whiting vessels, while it has increased by 73% for non-whiting vessels. This was partially driven by

¹³It is important to note that the EDC forms capture only costs that are directly related to vessel fishing operations, and do not include other expenses such as vehicles or office costs that may be related to the fishing business. Therefore, the net revenue reported here is an overestimate of the true net revenue.

high sablefish prices in 2011. The mean and standard deviation of revenue per pound is much higher for non-whiting vessels, reflecting the higher value per fish and the mix of species delivered. Variable cost net revenue per ton of catch has increased by 107% for the non-whiting vessels, while it has decreased by 5% for the whiting vessels.

6.2 Fleet-wide

Legend

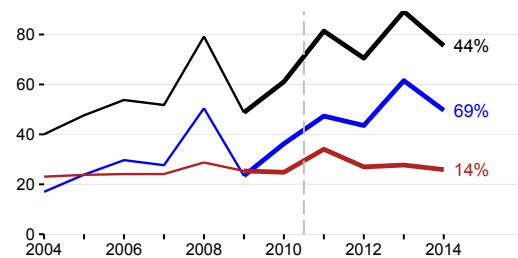
- Whiting vessels
- Non-whiting vessels
- All vessels

Fleet-wide metrics and definitions

Annual

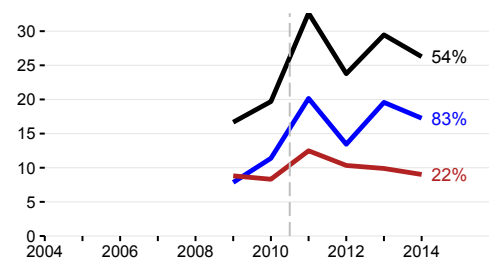
Revenue (millions of \$)

Fleet-wide revenue is the total revenue generated by the fleet in the catch share fishery in each year. Revenue captures changes in total harvest and ex-vessel prices.



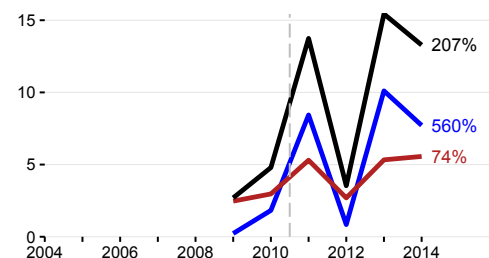
Variable cost net revenue (millions of \$)

Variable cost net revenue is revenue minus variable costs (costs that vary with the level of participation, such as crew, fuel, buyback fees, observers, and other variable costs) associated with the catch share program. Variable cost net revenue is a measure of the fleet's operating profit.



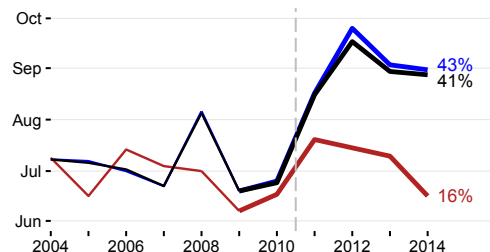
Total cost net revenue (millions of \$)

Total cost net revenue is revenue minus variable and fixed costs (costs that do not vary with the level of participation, such as equipment and gear purchases) associated with the catch share program. Total cost net revenue is a longer-term measure of profitability for the fleet as a whole.



Date when 50% of total catch was landed (day of year)

The date on which 50% of the total volume of catch was landed in the fishery measures broad-scale changes in the seasonality of fishing for catch shares fish. It can also indicate changes in total allowable catch and annual catch limits; it may take the fleet longer to catch a higher TAC/ACL.



Fleet-wide indicators provide information about net benefits of the fishery and the performance of the fishery as a whole. Total revenue has increased for the whiting vessels, the non-whiting vessels, and for all vessels combined. The 69% increase in revenue in the whiting fleet resulted primarily from increases in TAC, because average prices (or revenue per ton) decreased by about 15%. When costs are accounted for, variable cost net revenue and total cost net revenue have increased for both the whiting and non-whiting vessel categories as well.

There has been a shift in the timing of the fishing seasons toward later in the year, especially in the whiting fishery, as indicated by the date when 50% of the total catch was landed. Half of the whiting catch was landed 43% later in 2011-2014 (when it was landed in early September) than in 2009-2010 (when it was landed in mid-June). Although this metric is also influenced by the total allowable catch (most notably in the whiting fishery where nearly all of the TAC is landed, and TAC varies substantially from year to year), much of the effect is due to decreased fishing effort at the beginning of the season in favor of later in the season. The non-whiting fishery has shifted to later in the year but by much less, from mid-June in 2009-2010 to early July in 2011-2014.

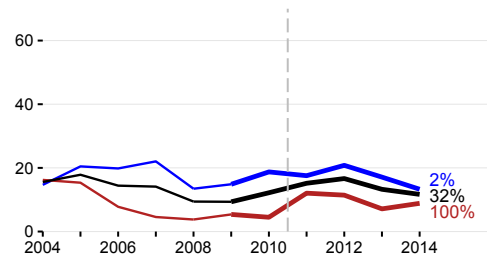
6.3 Social and Regional Metrics

Legend

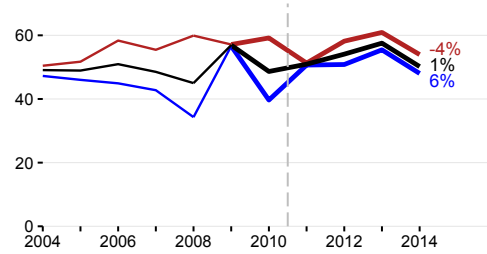
- Whiting vessels
- Non-whiting vessels
- All vessels

State-level landings metrics and definitions

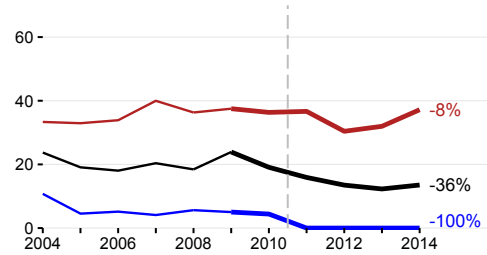
Share of landings in Washington (percent of revenue)



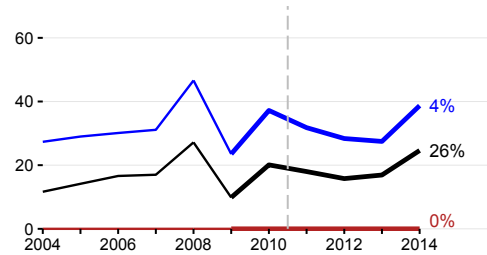
Share of landings in Oregon (percent of revenue)



Share of landings in California (percent of revenue)



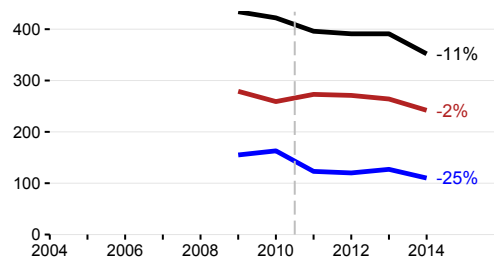
Share of landings (deliveries) at sea (percent of revenue)



Employment

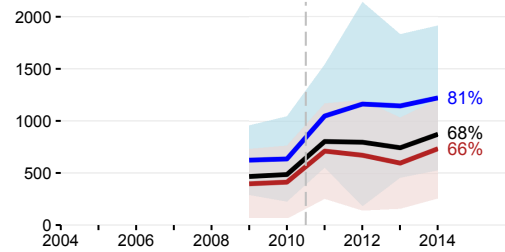
Number of positions

Number of positions (including captain and crew) is a lower bound for employment in the fishery, and is affected by positions per vessel and the number of vessels fishing.



Daily crew wages (average wage per day per position, \$)

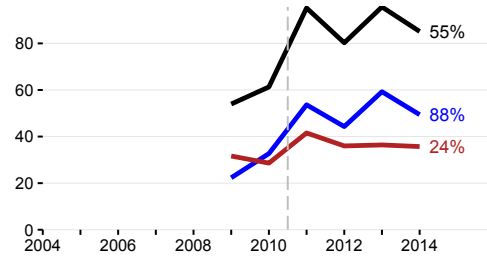
Average daily wage paid to a crewmember operating in the limited entry/catch share fishery.



Economic Input/Output Impacts

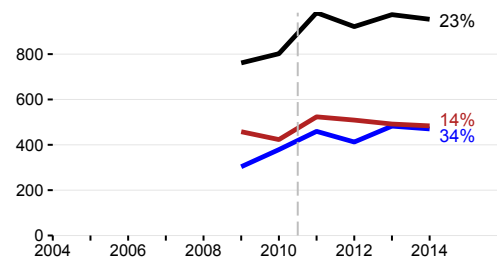
Income (millions of \$)

Total impacts on income of the West Coast Groundfish Trawl Catch Share fishery. Total impacts include direct, indirect, and induced income effects, as measured by the IO-PAC model [8, 9].



Employment (number of jobs)

Total impacts on employment of the West Coast Groundfish Trawl Catch Shares fishery. Total impacts include direct, indirect, and induced employment effects, as measured by the IO-PAC model [8, 9].



Overall, the share of total landings by all vessels has increased in Washington (by 32%) and Oregon (by 1%), and decreased in California (by -36%). The decrease in California landings was driven by a decrease in the share of landings by whiting vessels which has decreased to zero. The share of landings by non-whiting vessels in California decreased by only 8%. The share of landings by whiting vessels stayed roughly constant in Washington (2%), Oregon (6%), and at sea (4%). The share of landings by non-whiting vessels in Washington increased by 100%, while decreasing in Oregon (-4%) and California (-8%). Non-whiting vessels do not land fish at sea.

The total number of positions (including captain and crew) has decreased by 25% in the whiting category, and has decreased by 2% in the non-whiting category. This is partially due to the decrease in the number of vessels fishing for both whiting and non-whiting (which are categorized with the whiting vessels). The total number of positions decreased by 11% overall, which was driven by the overall decrease (-14%) in the number of active vessels. However, crew wages (average wage per day) have increased by 66% in the non-whiting category, 81% in the whiting category, and 68% overall.

Economic impacts are derived from the Northwest Fisheries Science Center Input-Output model for Pacific Coast Fisheries (IO-PAC), which is designed to estimate the changes in economic contributions and economic impacts resulting from policy, environmental, or other changes that affect fishery harvest [8, 9]. Total impacts include direct, indirect, and induced effects of changes in fishery harvest. The impacts reported here exclude processor contributions, as those will be included in the metrics for the processor sectors of the fishery.

The total economic impacts of the fishery on income increased by 55%, to over \$80 million in each year after the catch share program. The increase was driven more strongly by the whiting vessels (especially by increased TAC and ACLs), which increased by 88% compared to 24% for the non-whiting vessels.

The total economic impacts of the fishery on employment increased by 23%. Even though direct employment in both vessel categories decreased (by 25% for whiting, and 2% for non-whiting), the total impact increased. The increase in total employment impacts was driven by increases in revenue for the whiting category (which induces higher employment outside of the fishery, in economic sectors that support it). Note that these numbers are affected by the inclusion of vessels that fish for both whiting and non-whiting in the “whiting vessels” category. Increasing specialization has resulted in a number of vessels changing categories (whiting to non-whiting), resulting in an increase in the number of jobs in the non-whiting fishery and a decrease in the number of jobs in the whiting fishery, all else equal. Thus, the metric slightly overstates the change in employment impacts of the non-whiting fishery and understates the change in employment impacts of the whiting fishery. The level of economic impacts on employment are similar for the whiting and non-whiting sectors (between 400 and 500 jobs annually in each year after the catch share program).

Part II

Catcher-processor vessels

7 Demographic Indicators

Catcher-processors are vessels that both catch and process fish on-board. Revenue is measured in terms of production value. On the West Coast, catcher-processors that participate in the IFQ program fish for Pacific whiting. The catcher-processor sector is allocated 34% of the U.S. allocation of Pacific whiting. While the 2011 catch share program dramatically changed the structure of the shoreside Pacific whiting and mothership fisheries, the catcher-processor sector experienced fewer changes, and has continued to operate as a single cooperative since 1997, when the Pacific Whiting Conservation Cooperative (PWCC) was formed. Most vessels that participate in the Pacific whiting fishery on the West Coast also participate in the Walleye (Alaska) pollock fishery in the Bering Sea and Aleutian Islands; however, we do not collect data concerning their activities in Alaska.

Legend

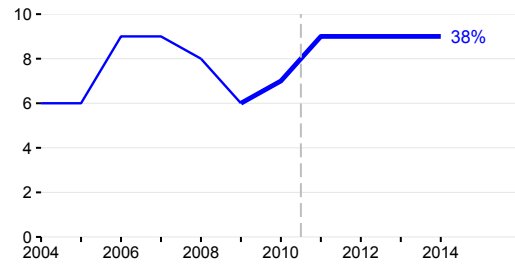
Whiting vessels

Standard deviation of whiting vessels

Metric and definition

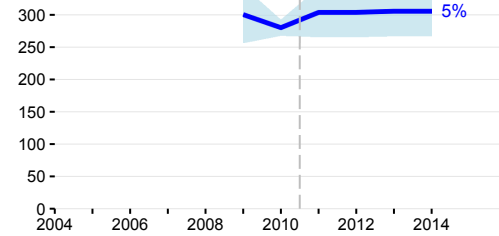
Number of catcher-processors operating

Changes in the number of catcher-processors operating can be an indication of consolidation or increases in efficiency. It can also reflect the variation in the annual total allowable catch, or changes in the number of vessels needed for operation in Alaska.



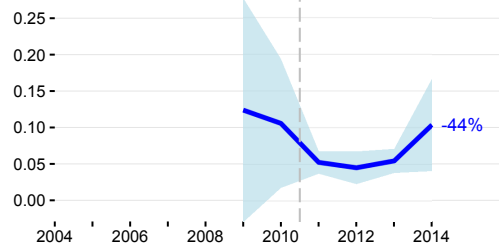
Length of vessels (ft)

The average length of vessels reflects the mix of active participants in each year.



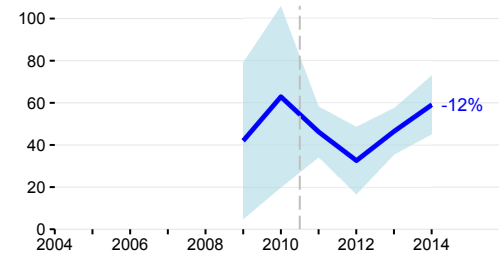
Proportion of production from West Coast Pacific whiting fishery

Measures how reliant vessels are on fish from the whiting fishery versus other fisheries.



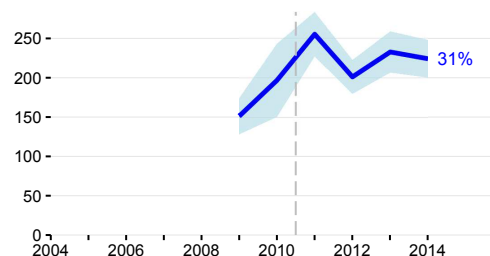
Days at sea in West Coast Pacific whiting fishery

The average number of days at sea targeting whiting on the West Coast may indicate changes in TAC, specialization, efficiency, or consolidation.



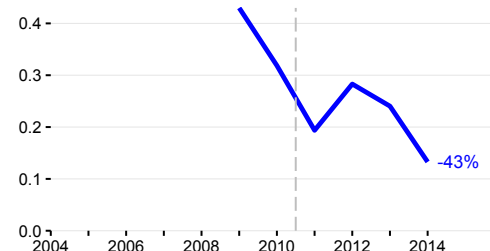
Total days at sea in all fisheries

This metric can be compared to the average days at sea on the West Coast to help determine the extent to which vessels are changing their patterns of participation.



Gini coefficient of Pacific whiting catch share revenue

Measures the degree of revenue concentration among vessels. A value of zero would represent all vessels earning the same revenue, and a value of one would represent one vessel earning all of the revenue. The value of the Gini coefficient can be affected by fleet consolidation and specialization.



Herfindahl- Hirschman Index (HHI)

The HHI is a measure of market concentration. It is calculated as the sum of the squares of the market shares, defined here by the share of catch share revenues earned by each vessel. Smaller numbers indicate lower market concentration.



Between six and nine catcher-processors have operated in the West Coast Pacific whiting fishery since 2004. Nine have operated in every year after the catch share program, a 38% increase from the two years prior to the program, likely attributable to a higher TAC.

The proportion of their total landings from the West Coast Pacific whiting fishery fell by 44%. The fleet fished fewer days on average in 2011 and 2012, but days at sea in the West Coast Pacific whiting fishery increased in 2013-2014, resulting in a decrease of 12% overall. Total days at sea (which includes fishing in Alaska) increased by 31%.

The Gini coefficient fell by 43%, as did the HHI, reflecting a more equal distribution of revenue among vessels.

8 Economic Indicators

8.1 Catcher-processor averages

Legend

— Whiting vessels

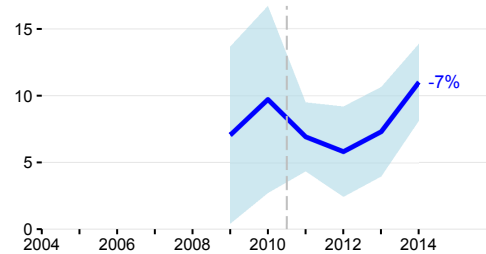
Standard deviation of whiting vessels

Vessel average metrics and definitions

Annual

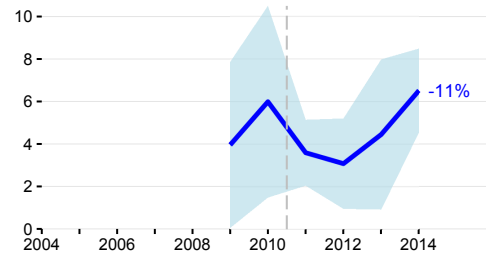
Revenue (average production value, millions of \$)

Average revenue in terms of production value captures changes in total harvest from fishing in the catch share program and product prices.



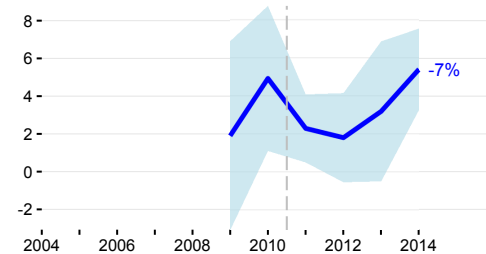
Variable cost net revenue (average, millions of \$)

Average variable cost net revenue is production value minus variable costs (costs that vary with the level of participation, such as crew, fuel, buyback fees, observers, and other variable costs). Average variable cost net revenue is a measure of the average vessel's operating profit.



Total cost net revenue (average, millions of \$)

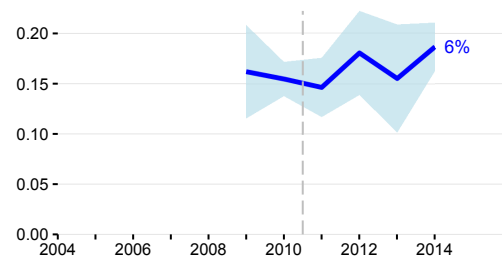
Average total cost net revenue is production value minus variable and fixed costs (costs that do not vary with the level of participation, such as equipment and gear purchases). Total cost net revenue is a longer-term measure of profitability. In any given year, a vessel may have a large fixed cost expense (such as a new engine), which may lead to negative or unusually low total cost net revenue.



Per day of fishing in the catch share fishery

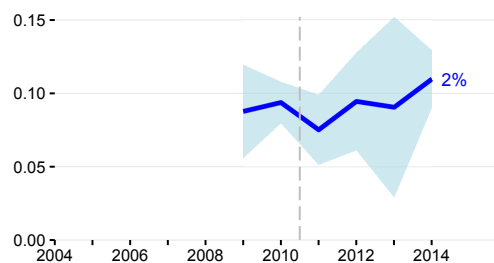
Revenue per day (average production value, millions of \$ per day)

Average revenue per day captures average gross earnings from a day of fishing and processing in the Pacific whiting catcher-processor fishery.



Variable cost net revenue per day (average, millions of \$ per day)

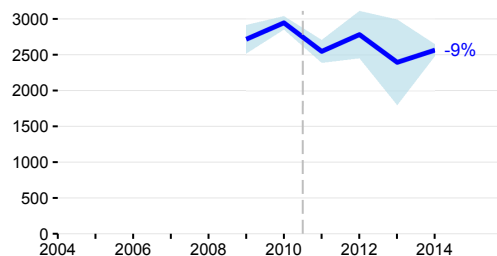
Average variable cost net revenue per day is production value minus variable costs per day of fishing associated with the catch share program. It is a measure of the average daily operating profit of the average vessel.



Per metric ton of catch in the catch share fishery

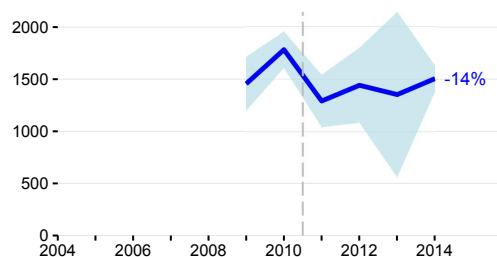
Revenue per ton (average \$ per ton)

Average revenue per metric ton of Pacific whiting is the average price of processed Pacific whiting.



Variable cost net revenue per ton (average \$ per ton)

Average variable cost net revenue per metric ton is analogous to per-ton operating profit margin for the average vessel, and is representative of the value of quota.



Average catcher-processor revenue fell by 7%, and variable cost net revenue and total cost net revenue fell by similar rates: 11% and 7%, respectively. This is likely due to the higher number of vessels actively participating in each year. Average revenue per day and variable cost net revenue per day reflected the pattern of days at sea in the Pacific whiting fishery, and increased by 6% and 2%, respectively. Average production revenue per ton of catch decreased somewhat (-9%), while average variable cost net revenue per ton of Pacific whiting catch decreased by 14%.

8.2 Fleet-wide

Legend

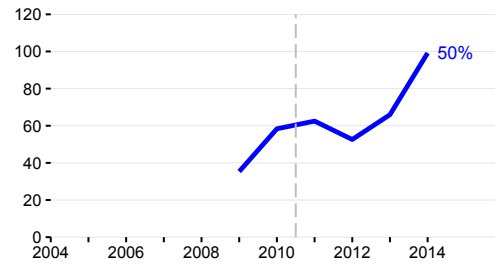
— Whiting vessels

Fleet-wide metrics and definitions

Annual

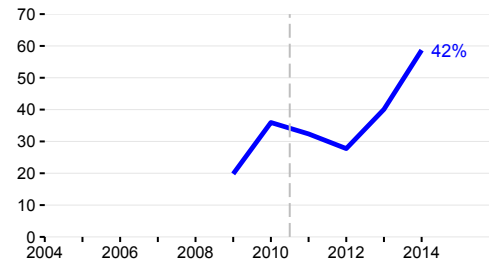
Revenue (production value, millions of \$)

Fleet-wide revenue is the total production value generated by the catcher-processor fleet in the West Coast Pacific whiting fishery in each year. Revenue captures changes in total harvest and product prices.



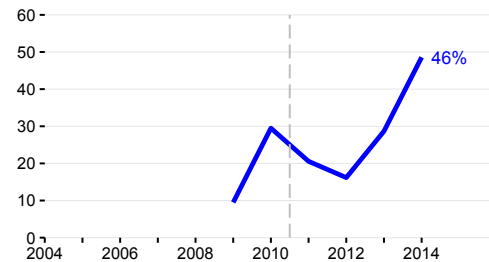
Variable cost net revenue (millions of \$)

Variable cost net revenue is production value minus variable costs (costs that vary with the level of participation, such as crew, fuel, buyback fees, observers, and other variable costs) associated with the West Coast Pacific whiting catcher-processor fishery. Variable cost net revenue is a measure of the fleet's operating profit.



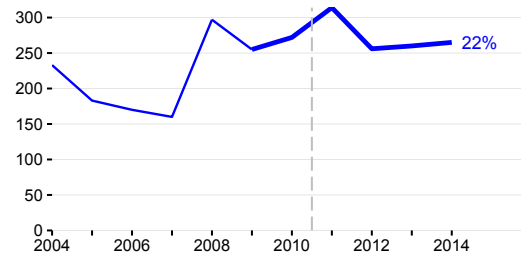
Total cost net revenue (millions of \$)

Total cost net revenue is production value minus variable and fixed costs (costs that do not vary with the level of participation, such as equipment and gear purchases) associated with the West Coast Pacific whiting catcher-processor fishery. Total cost net revenue is a longer-term measure of profitability for the fleet as a whole.



Date when 50% of total catch was landed (day of year)

The date (day of the year) on which 50% of the total volume of catch was landed in the fishery measures broad-scale changes in the seasonality of fishing for catch shares fish. It can also indicate changes in total allowable catch; it may take the fleet longer to catch a higher TAC.



In contrast to the vessel averages, fleet-wide revenue, variable cost net revenue, and total cost net revenue increased (by 50%, 42%, and 46%, respectively). Fleet-wide revenue per day and variable cost net revenue per day also increased substantially but decreased slightly in 2013, reflecting the increase in days at sea in the fishery.

The date when 50% of the total catch was landed, which is an indicator changes in the seasonality of the fishery, has increased by 22%, but is not outside the realm of what it has been in past years. This means that the timing of effort in the catcher-processor fishery has not experienced substantial changes.

9 Social and Regional Metrics

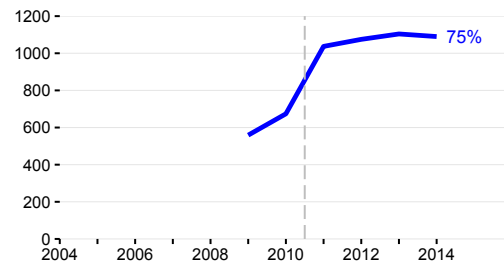
Legend

— Whiting vessels

Employment

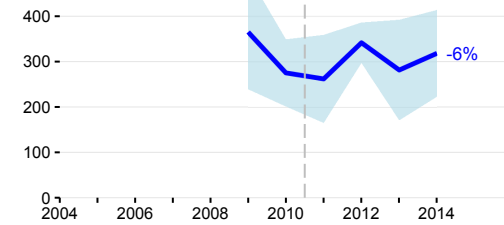
Number of positions

Number of positions (including captains, processing crew, and non-processing crew) is a lower bound for employment in the fishery, and is affected by positions per vessel and the number of vessels fishing.



Daily crew wages (average wage per day per position, \$)

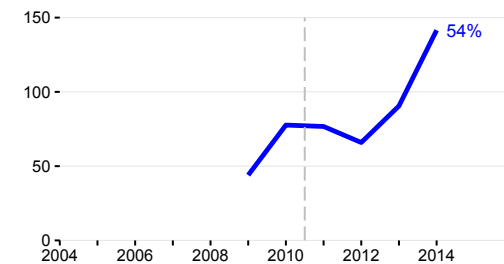
Average daily wage paid to a crew member working on vessels in the Pacific whiting catcher-processor cooperative.



Economic Input/Output Impacts

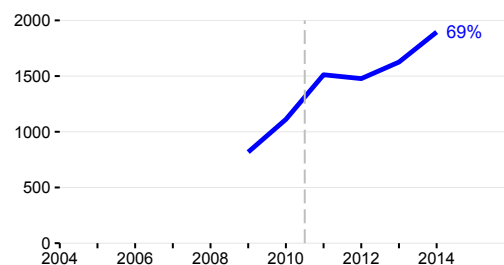
Income (millions of \$)

Total impacts on income of the West Coast Groundfish Trawl Catch Share catcher-processor sector. Total impacts include direct, indirect, and induced income effects, as measured by the IO-PAC model [8, 9].



Employment (number of jobs)

Total impacts on employment of the West Coast Groundfish Trawl Catch Shares catcher-processor sector. Total impacts include direct, indirect, and induced employment effects, as measured by the IO-PAC model [8, 9].



Catcher-processors deliver processed fish exclusively to ports in Washington.

The total number of positions increased by 75%, and daily crew wages decreased modestly, by 6%. This was driven by the decrease in the number of catcher-processors operating on the West Coast.

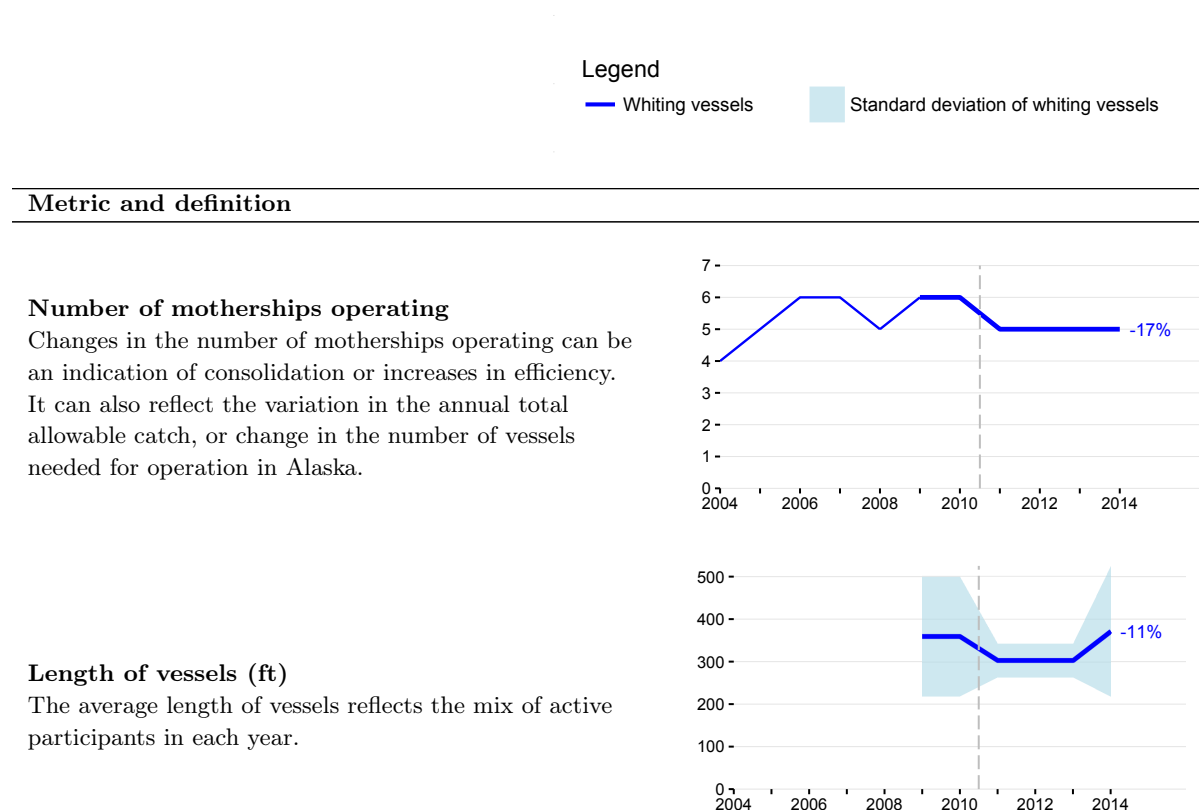
The total economic impacts of the fishery on income increased by 54%, to nearly \$150 million in 2014. The total economic impacts of the fishery on employment increased by 69%, which was driven by increases in direct employment and increases in revenue generated by the catcher-processor sector.

Part III

Mothership vessels

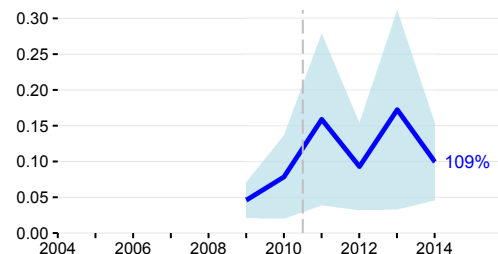
10 Demographic Indicators

Motherships are factory vessels that purchase and process fish delivered to them at sea by catcher vessels. Revenue is measured in terms of production value. The West Coast Groundfish Trawl Catch Share Program included the formation of a cooperative of mothership vessels that process Pacific whiting on the West Coast. Most motherships that participate in the Pacific whiting fishery on the West Coast also participate in the Walleye (Alaska) pollock fishery in the Bering Sea and Aleutian Islands; however, we do not collect data concerning their activities in Alaska.



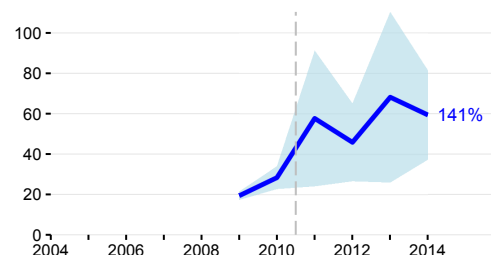
Proportion of total landings from West Coast Pacific whiting mothership cooperative

Measures how reliant vessels are on fish from the West Coast Pacific whiting fishery versus other fisheries.



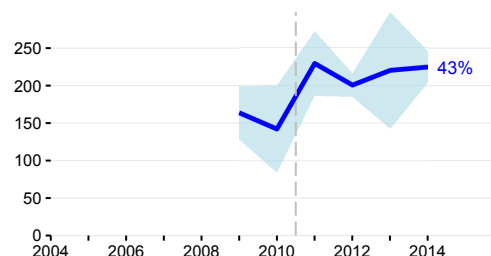
Days at sea in West Coast Pacific whiting mothership cooperative

The average number of days at sea targeting Pacific whiting on the West Coast may indicate changes in TAC, specialization, efficiency, or consolidation.



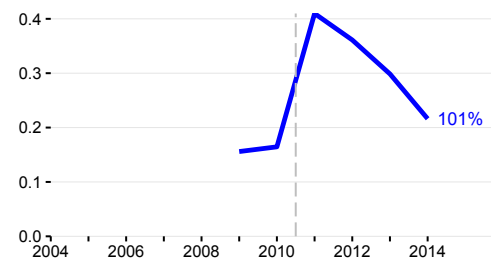
Total days at sea in all fisheries

This metric can be compared to the average days at sea on the West Coast to help determine the extent to which vessels are changing their patterns of participation.



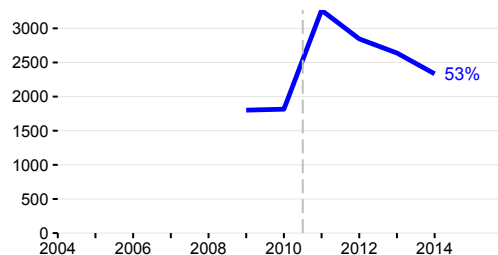
Gini coefficient of revenue from the West Coast mothership cooperative

Measures the degree of revenue concentration among vessels. A value of zero would represent all vessels earning the same revenue, and a value of one would represent one vessel earning all of the revenue. The value of the Gini coefficient can be affected by fleet consolidation and specialization.



Herfindahl- Hirschman Index (HHI)

The HHI is a measure of market concentration. It is calculated as the sum of the squares of the market shares, defined here by the share of catch share revenues earned by each vessel. Smaller numbers indicate lower market concentration.



Between four and six motherships have operated in the West Coast Pacific whiting fishery since 2004. Five vessels have participated in each year after the formation of the cooperative in 2011, a 17% decrease from the two years prior, when all six vessels participated. The average length of vessels decreased, indicating

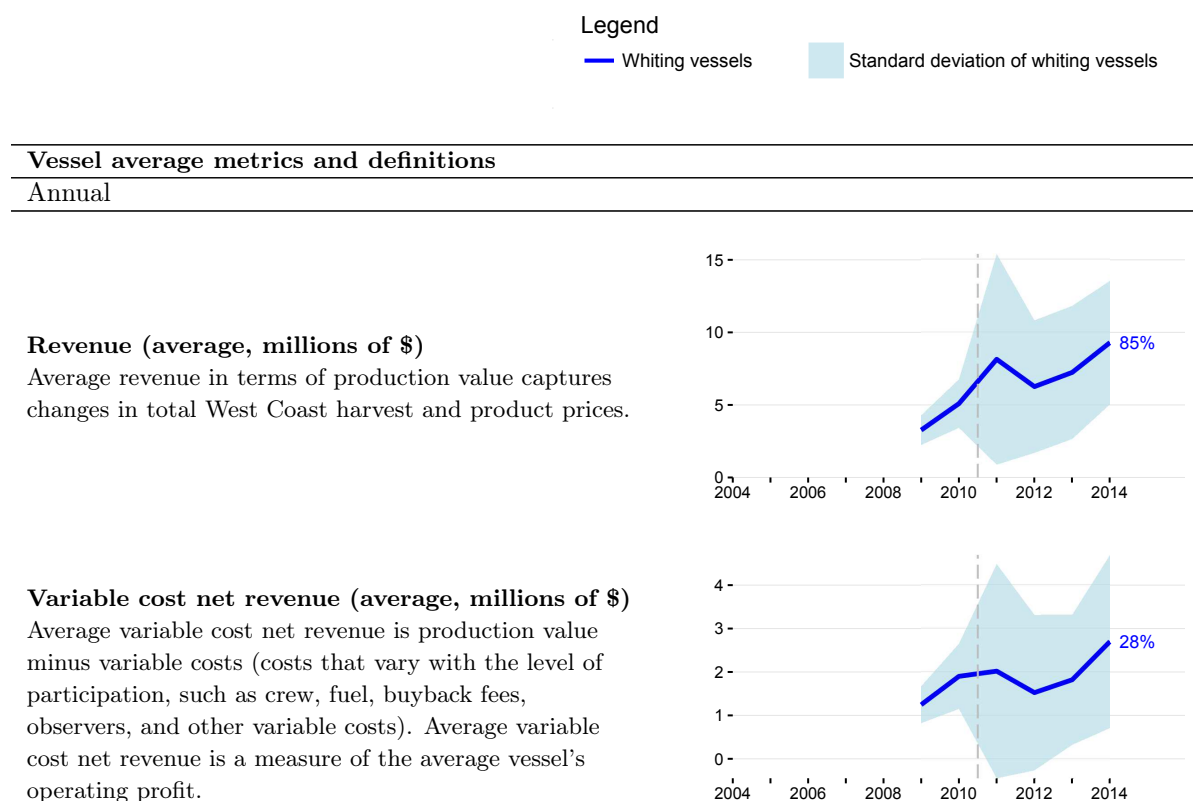
that one of the larger vessels did not participate in the West Coast fishery in 2011-2013.

The proportion of landings from fishing in the West Coast mothership cooperative has increased by 109%, and average days at sea has increased by 141%, all of which can be expected from the number of active vessels being reduced from six to five. Average days at sea in all fisheries (including Alaska fisheries) increased by 43%.

The Gini coefficient of catch share revenue increased by 101%, which was also driven by the reduction in vessels fishing in the mothership cooperative from six to five.

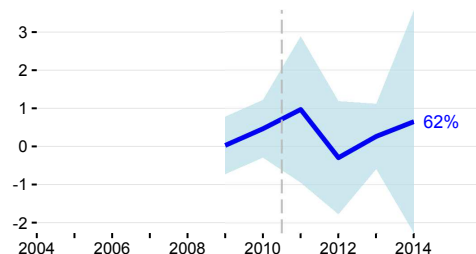
11 Economic Indicators

11.1 Mothership averages



Total cost net revenue (average, millions of \$)

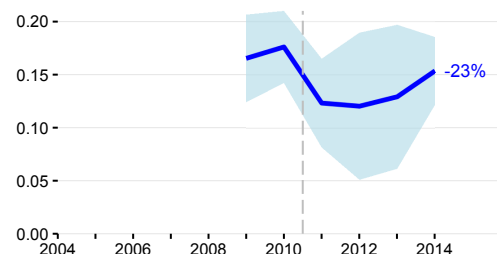
Average total cost net revenue is production value minus variable and fixed costs (costs that do not vary with the level of participation, such as equipment and gear purchases). Total cost net revenue is a longer-term measure of profitability. In any given year, a vessel may have a large fixed cost expense (such as a new engine), which may lead to negative or unusually low total cost net revenue.



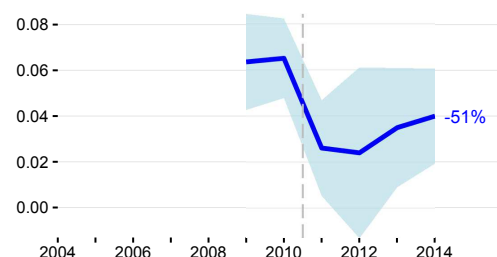
Per day of operation in the catch share fishery

Revenue per day (average, millions of \$)

Average revenue per day captures average gross earnings from a day of operating in the mothership cooperative.

**Variable cost net revenue per day (average, millions of \$)**

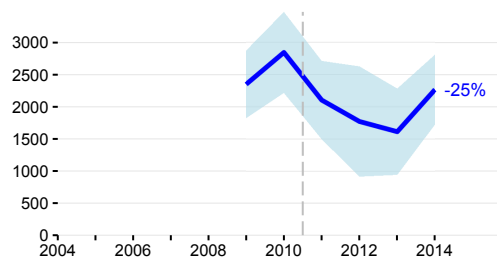
Average variable cost net revenue per day is production value minus variable costs per day of fishing in the mothership cooperative. It is a measure of the average daily operating profit of the average vessel.



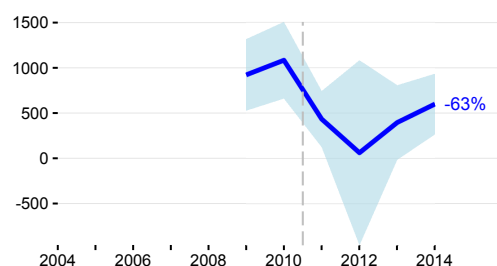
Per metric ton of production in the catch share fishery

Revenue per ton of production (average \$)

Average revenue per metric ton of Pacific whiting is the average price of processed Pacific whiting.

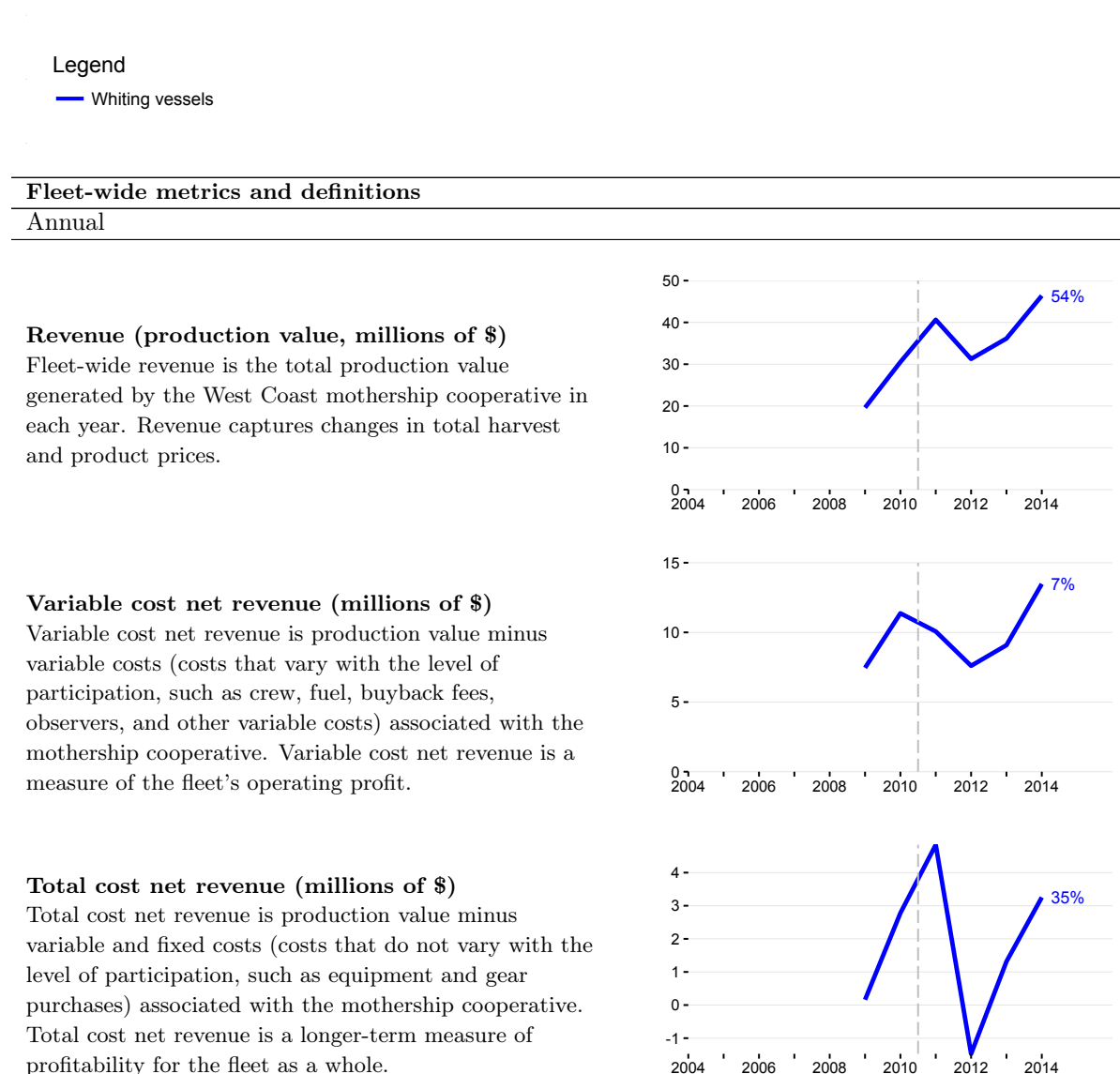
**Variable cost net revenue per ton of production (average \$)**

Average variable cost net revenue per metric ton is analogous to per-ton operating profit margin for the average mothership, and is representative of the value of quota.



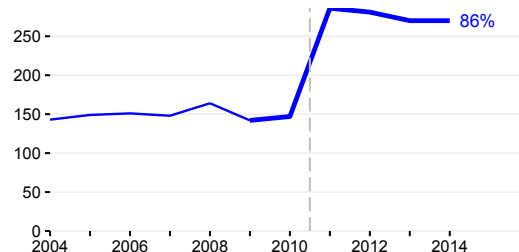
Average mothership revenue, variable cost net revenue, and total cost net revenue all increased, by 85%, 28%, and 62%, respectively. However, given that each vessel fished more days, revenue per day and variable cost net revenue per day both decreased. Revenue per ton of production and variable cost net revenue per ton of production decreased by 25% and 63%, respectively.

11.2 Fleet-wide



Date when 50% of total catch was landed (day of year)

The date (day of the year) on which 50% of the total volume of catch was landed in the fishery measures broad-scale changes in the seasonality of fishing for catch shares fish. It can also indicate changes in total allowable catch; it may take the fleet longer to catch a higher TAC.



The fleet-wide indicators show patterns similar to the average mothership vessel indicators. Total revenue, variable cost net revenue, and total cost net revenue increased by 54%, 7%, and 35%, respectively.

In the post catch share years, 50% of the total landings have not been caught until late September, compared to early June in the pre catch share year. This indicates a substantial shift in the timing of effort in the mothership fishery toward later in the year.

12 Social and Regional Metrics

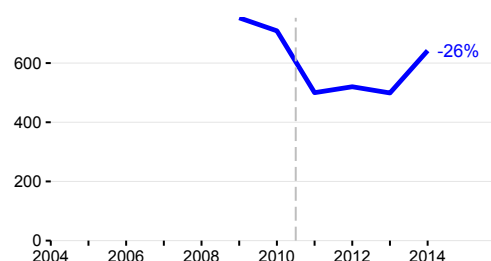
Legend

— Whiting vessels

Employment

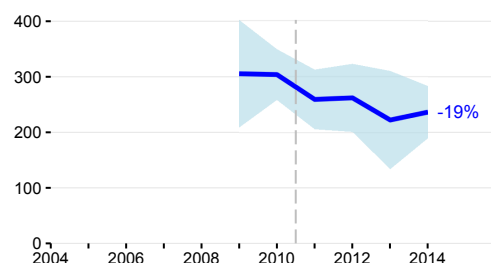
Number of positions

Number of positions (including captains, processing crew, and non-processing crew) is a lower bound for employment in the fishery, and is affected by positions per vessel and the number of vessels fishing.



Daily crew wages (average wage per day per position, \$)

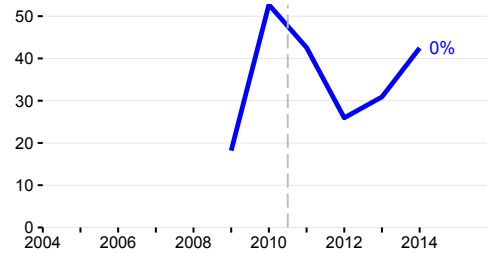
Average daily wage paid to a crew member working on vessels in the mothership cooperative fishery.



Economic Input/Output Impacts

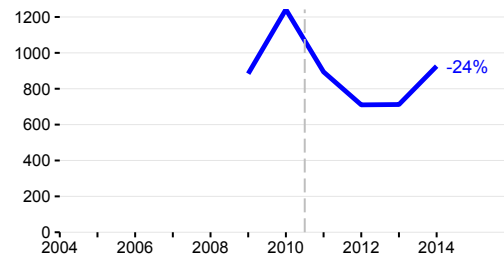
Income (millions of \$)

Total impacts on income of the West Coast Groundfish Trawl Catch Share mothership sector. Total impacts include direct, indirect, and induced income effects, as measured by the IO-PAC model [8, 9].



Employment (number of jobs)

Total impacts on employment of the West Coast Groundfish Trawl Catch Shares mothership sector. Total impacts include direct, indirect, and induced employment effects, as measured by the IO-PAC model [8, 9].



Motherships receive all deliveries of fish at-sea, and deliver processed product exclusively to ports in Washington.

The total number of positions decreased by 26%, which is expected given the decrease in the number of vessels fishing. Average crew wages, however, also fell by 19%, which is slightly more than they fell in the catcher-processor sector.

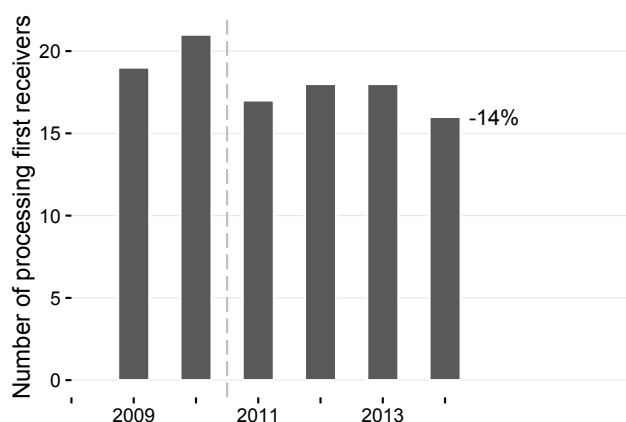
The total economic impacts of the mothership sector on income did not change on average, but varied considerably from \$20 million to over \$50 million during the time period. The total economic impacts of the mothership sector on employment decreased by 24%.

Part IV

Shorebased processors

13 Demographic Indicators

The catch share program requires all facilities that receive fish harvested within the shorebased catch share program to have a first receiver site license and submit data to the EDC program. Facilities that purchase catch share groundfish but do not process fish are also included in the catch share program. These non-processors are included in the EDC reports published by the Northwest Fisheries Science Center [6] but are excluded from this report. There were an average of four non-processing first receivers operating in each year from 2009-2014. The figure below shows the number of processing first receivers since 2009. The number of processing first receivers has decreased by 14% from 2009-2010 to 2011-2014.

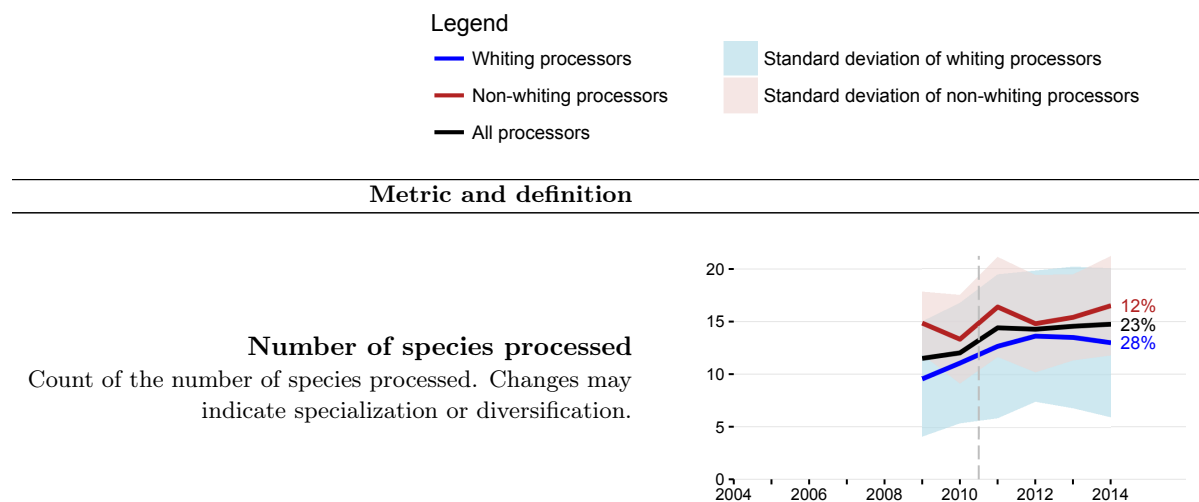


Unlike the catcher vessel, catcher-processor, and mothership sectors, it is difficult to disaggregate the processor data used for the indicators into fish caught within the catch share program and fish caught outside the catch share program.¹⁴ Much of the information on the EDC forms for shorebased processors is collected at the species level, not the fishery level. Therefore, it is difficult to determine exactly the proportion of processed groundfish from fish caught under the catch share program versus fish caught in the open access fishery or the primary sablefish fishery. However, from 2009-2014 an average of 93% of groundfish *purchased* by processors that filled out an EDC form was fish caught with a trawl permit (see the table below). While it would be ideal to isolate costs associated with production of catch share groundfish, we propose that the information presented here is largely representative of the economics of catch share groundfish production.

¹⁴Several unreasonable assumptions would have to be made, including: 1) the costs to produce catch share and non-catch share fish are identical, 2) catch share fish is purchased from vessel and non-vessel sources in the same proportion, 3) catch share and non-catch share fish are processed into different product types in the same proportions.

Percent of total groundfish purchased that were caught as part of the catch share program	
2009	85%
2010	96%
2011	88%
2012	96%
2013	94%
2014	98%

Like the catcher vessel sector, the scale of the processing industry for Pacific whiting can obscure changes that may occur in the portion of the industry that does not purchase Pacific whiting. Processors that purchase whiting tend to be larger, and many received “processor quota” for whiting that was allocated as a part of the rationalization process.¹⁵ All processors that purchase Pacific whiting also purchase other non-whiting groundfish catch share species. Therefore, for the performance metrics we divide the processors into two mutually exclusive groups: processors that process both Pacific whiting and non-whiting groundfish (hereafter: “Whiting processors”), and processors that process exclusively non-whiting groundfish as a part of the catch share program (“Non-whiting processors”).¹⁶ This allows the investigation of potentially divergent trends for each group of processors.



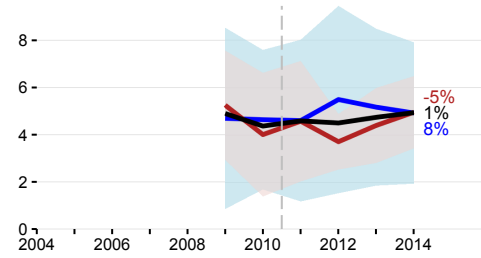
¹⁵Eligibility and allocation percentages were determined by historical deliveries to shorebased processors during a set of control dates (1994 to 2004). <https://www.federalregister.gov/articles/2013/01/02/2012-31546/fisheries-off-west-coast-states-pacific-coast-groundfish-fishery-management-plan-trawl>

¹⁶Both categories of processors also process other species of fish and shellfish that are not part of the catch share program.

Exponential Shannon Index

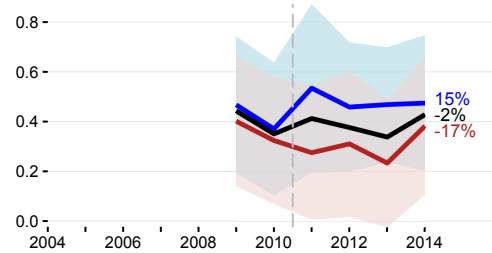
Measures the income diversification of a processor across revenue sources. A larger number corresponds to increased diversification. Changes may indicate specialization or diversification.

$$ESI = -\exp \left[\sum_{i=1}^{15} p_i \ln(p_i) \right] \text{ where } p_i \text{ is the proportion of revenue from species } i.$$



Proportion of production value from West Coast groundfish

Measures the reliance of processors on West Coast groundfish versus other species.

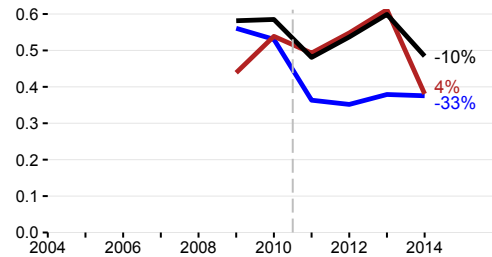


Gini coefficient of revenue from groundfish

Measures the degree of concentration among processors.

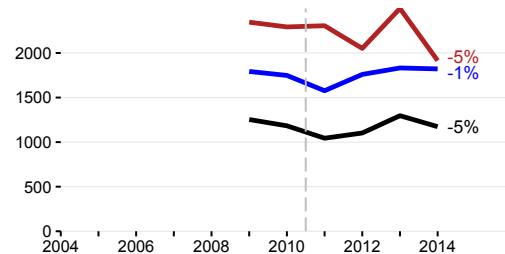
A value of zero would represent all processors earning the same revenue, and a value of one would represent one processor earning all of the revenue in the industry.

The value of the Gini coefficient can be affected by consolidation and specialization.



Herfindahl- Hirschman Index (HHI)

The HHI is a measure of market concentration. It is calculated as the sum of the squares of the market shares, defined here by the share of groundfish revenues earned by each processor. Smaller numbers indicate lower market concentration.



The number of species processed increased for both categories of processors, and the industry as a whole, while the Exponential Shannon Index, which measures income diversification across revenue sources, decreased slightly for the non-whiting processors. This could mean that while non-whiting processors are processing a greater number of species, their dependence on them for revenue is low. Perhaps relatedly, the proportion of total revenue from groundfish increased for the whiting processors, but decreased for the non-whiting processors (by 17%).

The Gini coefficient of revenue from groundfish increased slightly for the processors that do non-whiting only (by 4% over the period), but decreased for the whiting processors (by -33%). This indicates that revenue

became less concentrated in the group of processors that process Pacific whiting.

14 Economic Indicators

14.1 Processor averages

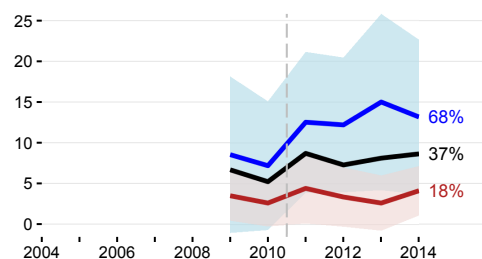


Processor average metrics and definitions

Annual

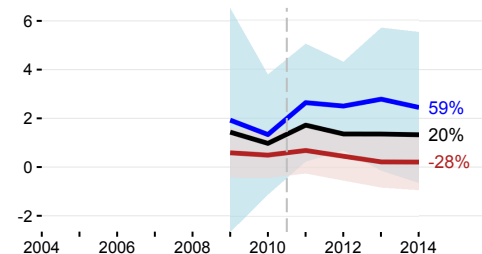
Revenue (production value, millions of \$)

Average revenue per processor from West Coast groundfish in terms of production value. Revenue captures changes in total purchases, markups, and output product prices.



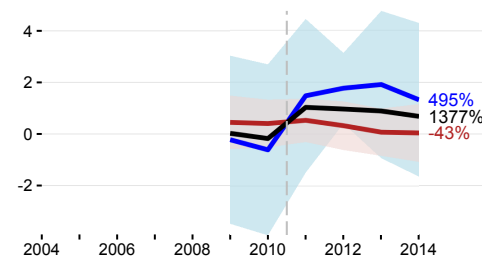
Variable cost net revenue (millions of \$)

Average variable cost net revenue is production value minus variable costs (costs that vary with the level of participation, such as fish purchases, labor, and packaging). Average variable cost net revenue is a measure of the average processor's operating profit.



Total cost net revenue (millions of \$)

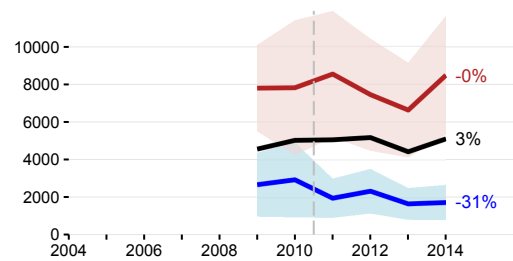
Average total cost net revenue is production value minus variable and fixed costs (costs that do not vary with the level of participation, such as capitalized expenditures on buildings, or rent and repairs on buildings and machinery). Total cost net revenue is a longer-term measure of profitability. In any given year, a processor may have a large fixed cost expense (such as a new building), which may lead to unusually low total cost net revenue.



Per metric ton of groundfish products

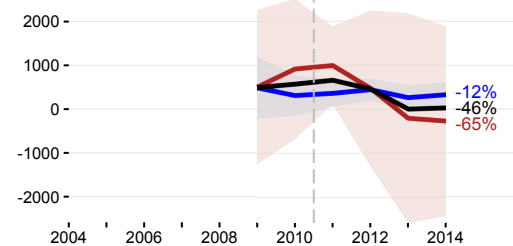
Revenue per ton (average \$)

Average revenue per metric ton of groundfish products is analogous to an average price index (over all species and products produced).



Variable cost net revenue per ton (average \$)

Average variable cost net revenue per metric ton is revenue minus variable costs per pound of processed groundfish. Average variable cost net revenue per metric ton is analogous to per-ton operating profit margin for the average processor.



Average revenue and average variable cost net revenue increased for the whiting processors (by 68% and 59%, respectively). Note that total cost net revenue for whiting processors and all processors was negative in the pre catch share years, and positive in the post catch share years, resulting in percentage changes that should be interpreted with caution. In contrast, for processors that do only non-whiting products, average revenue increased by 18%, but average variable and total cost net revenue fell by 28% and 43%, respectively. Average revenue per ton remained constant for non-whiting processors, but decreased for whiting processors, indicating a decrease in average prices for products produced by whiting processors. Variable cost net revenue per ton decreased for both categories, but by a larger percentage for non-whiting processors.

14.2 Industry-wide

Legend

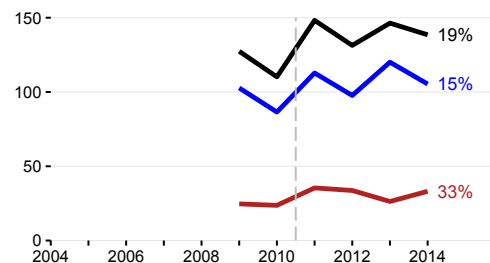
- Whiting processors
- Non-whiting processors
- All processors

Industry-wide metrics and definitions

Annual

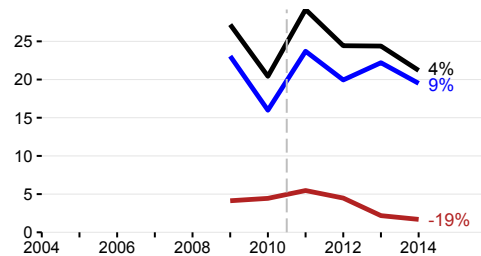
Revenue (production value, millions of \$)

Total revenue generated by the processors from West Coast groundfish production captures changes in total purchases, markups, and output product prices.



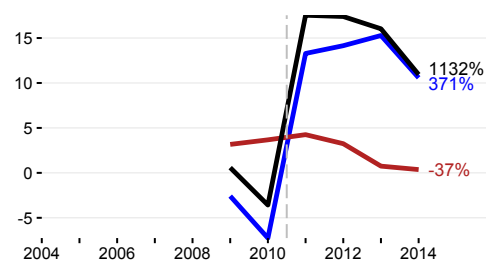
Variable cost net revenue (millions of \$)

Variable cost net revenue is production value minus variable costs (costs that vary with the level of participation, such as fish purchases, labor, and packaging) associated with groundfish processing. Variable cost net revenue is a measure of the industry's operating profit.



Total cost net revenue (millions of \$)

Total cost net revenue is production value minus variable and fixed costs (costs that do not vary with the level of participation, such as capitalized expenditures on buildings, or rent and repairs on buildings and machinery) associated with processing groundfish on the West Coast. Total cost net revenue is a longer-term measure of profitability for the industry as a whole.



The total revenue (in terms of production value) generated by the processing industry as a whole increased by 19%. Total production value is higher for the whiting processors, and has increased by 15%. Variable cost net revenue increased by 9% for this group. For the non-whiting processors, production value has increased by 33%, while variable cost net revenue has decreased by 19%. Total cost net revenue is much more variable; for the whiting processors it increased by 367%, while for the non-whiting only processors it decreased by 37%. For the processing sector as a whole, however, total cost net revenue increased by 1096%. Note that in this case, total cost net revenue was negative in the pre catch share period, so the percentage changes are calculated using the absolute value and should be interpreted with caution.

15 Social and Regional Metrics

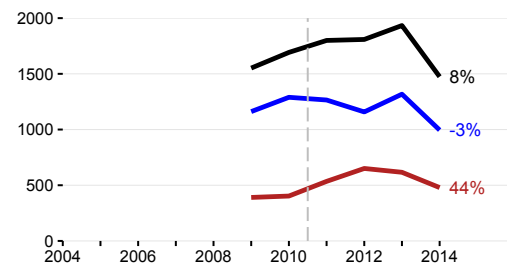
Legend

- Whiting processors
- Non-whiting processors
- All processors

Employment indicators and definitions

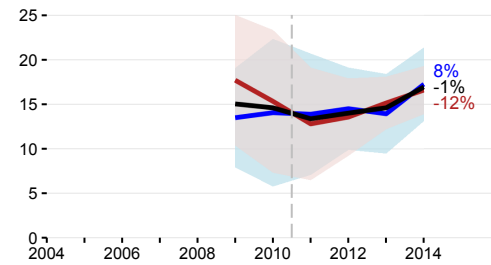
Number of workers

Average number of workers over a year (including processing and non-processing employees), which is a lower bound for employment in the industry.



Average hourly compensation (\$)

Average hourly compensation paid to a processing worker in the West Coast groundfish fishery.



The share of production by state will be reflected in the share of landings by state calculated for the catcher vessels; see section 6.3.

The number of workers employed by the processing industry increased by 8% overall, driven by an increase in the number of workers at non-whiting processing facilities (which grew by 44%). However, the total number of workers showed a decline in 2014. Average hourly compensation to production workers fell by 12% for non-whiting processors, and increased by 8% for workers at whiting processing facilities

Economic Input/Output model impacts are not yet completed for the processing sector.

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- [3] Cobb CW, Rixford C (1998) *Lessons Learned from the History of Social Indicators* (Redefining Progress, San Francisco).
- [4] Steiner E, Warlick A, Guldin M, Pfeiffer L (2016) Economic data collection program mothership report (2009-2014)., (NOAA Fisheries Northwest Fisheries Science Center), Technical report.
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