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Can vessel buybacks pay off: An evaluation of an industry funded fishing vessel buyback

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A B S T R A C T

Fishing vessel and permit buyback programs have been implemented to reduce excess capacity and improve profitability in a number of fisheries around the world. These programs are generally publicly funded, but in a few cases they have been financed by loans to be paid back by the remaining fleet. In 2003, a buyback permanently removed 91 vessels and 239 fishing permits from the Pacific groundfish trawl fishery and associated corollary fisheries of Dungeness crab and pink shrimp. The buyback was financed with $10 million in public funding and a $36 million loan to be repaid over 30 years with fees on landings. In the same year, a control date was set for catch share program in the groundfish trawl fishery. When the catch share program was implemented in 2011, the permit owners that remained in the fishery after the buyback were allocated the quota shares that would otherwise have been issued to the permits bought back in 2003. Estimates of the annual profits generated by this quota are compared to the cost of servicing the buyback loan. The results provide evidence that a buyback program, when implemented in conjunction with catch shares, can enable a sustained increase in profitability for the remaining vessels sufficient to justify its cost. However, using landings taxes as the mechanism to repay the loan may result in a mismatch between those who benefit from and pay for the buyback.

1. Introduction

Fishing permit and vessel buyback programs (sometimes called capacity reduction programs or decommissioning schemes) have been implemented in a number of fisheries around the world to reduce excess capacity and thereby improve efficiency and profitability of the remaining fleet [1–3]. Buybacks have also been used to modernize fleets, provide disaster assistance, compensate parties for redistribution of catch rights, or compensate fishers for area closures or gear restrictions implemented for conservation reasons [3]. In a few cases, buybacks have been used to facilitate the transition to a catch share management system (e.g., individual fishing quotas (IFQs) or allocations to fishing cooperatives). Annala [4] notes that when the quota management system was introduced in New Zealand, the government bought back catch histories from inshore fishers in order to reduce total allowable catches (TACs) for depleted inshore stocks. Pascoe et al. [5] indicate that a buyback program implemented in the Northern prawn fishery in Australia was conditioned on agreement by the industry to move to an IFQ management system. Squires [3] states that in the Pacific coast groundfish trawl fishery, "which had been plagued by losses", the "buybacks restoring profitability gave breathing room to decide further actions and enhance positive economic behavior" allowing for the eventual implementation of a catch share system.

A criticism of buybacks is that, even if they succeed at increasing efficiency and profitability in the short term, they encourage additional investment in capacity that erodes the original gains of the program [2,3,6–9]. Theoretical analysis and empirical studies done after buybacks have generally confirmed this [3,5,7]. The anticipation of future buyback programs may exacerbate the problem by increasing incentives for investments in capacity [7]. Thus a key to enabling lasting efficiency gains through a buyback is to ensure that incentives to replace fishing capacity are eliminated. Implementing a buyback in conjunction with an IFQ system might be expected to achieve this. An analysis of the 1997 buyback in the Southeast trawl fishery in Australia, which was already managed with IFQs, indicated efficiency gains persisted after the buyback was implemented [10]. However, Clark et al. [7] argue that, even with a planned future IFQ program and no expectations of a future publicly funded buyback, excess investment in the period leading up to implementation of the IFQ program will dissipate fishery rents.

Buyback programs are almost always publicly funded, but in a few cases they have been funded fully or partially by industry. In addition to

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the Pacific Coast groundfish buyback, which we discuss in more detail below, there was an industry-funded permit buyback in the US Pacific whiting fishery in 1997, and there were three buybacks in Alaska funded all or in part with loans to be paid back by industry. Notably, all of these preceded transitions to catch share systems that provided reasonably secure catch privileges for the remaining participants, and thus some assurance that gains in profitability resulting from the buyback would not be dissipated by a new race-for-fish.

The Pacific whiting buyback might more accurately be called a buy-in than a buyback. When a limited entry plan was implemented for the groundfish fishery in 1994, none of the catcher-processors currently participating in the fishery qualified for limited entry permits because they had no fishing history during the qualifying period. In order to remain in the fishery, the catcher-processor vessels purchased catcher vessel permits according to a formula based on vessel length and gross tonnage. As a result, 10 catcher-processors purchased an average of 11 permits each at a cost of around $1.5 million per catcher-processor [11]. In 1997, the catcher-processors voluntarily formed the Pacific Whiting Conservation Cooperative (PWCC) under which individual vessels were allocated secure shares of the sector's total allowable catch through a contractual agreement among the participants. The PWCC has continued to operate as a de facto catch share system ever since, and was officially recognized (and regulated) as a cooperative beginning in 2011.

The Alaskan buybacks began with the American Fisheries Act (AFA) of 1998, which authorized the buyout of nine large catcher-processors from the Bering Sea Aleutian Islands (BSAI) pollock fishery at a cost of $90 million financed with an appropriation of $15 million and a loan of $75 million to be paid back over 30 years with a landings fee [12]. In 2005, a reverse auction bidding process was used in the BSAI king and tanner crab fishery to permanently remove 25 fishing vessels and 62 fishing licenses and permits for $97 million to be paid back over 30 years with a landings fee [13]. In 2007, a buyout removed three fishing vessels and 12 fishing licenses and permits from the longline catcher-processor subsector of the BSAI non-pollock fishery financed with a $36 million loan to be paid back over 30 years with a landings fee [14]. A subsequent buyout in 2013 purchased a single latent permit from this fishery for $2.7 million, adding the cost to the original buyback loan. All of these buyouts preceded implementation of catch share systems – cooperatives for BSAI pollock and non-pollock catcher-processor sectors, and IFQs for BSAI crab.

The Pacific groundfish fishery buyback, the focus of this study, took place in 2003. It permanently removed 91 groundfish trawl vessels and associated limited entry permits (and an additional 121 state permits for Dungeness crab and pink shrimp held by these vessels) at a cost of $46 million. The buyback used a reverse auction that scored bids by dividing each bid amount by the average annual total ex-vessel value of the Pacific groundfish, Dungeness crab, and pink shrimp landed by the bidder's vessel (based on vessels' three highest total annual revenues during 1998, 1999, 2000, or 2001). The Pacific Coast groundfish buyback was financed with a combination of $10 million in public funds and a loan for $36 million. Approximately $28.4 million of the total $36 million buyback loan was to be paid back within 30 years with a 5% fee on ex-vessel revenue from all trawl-caught groundfish. The fee has also been applied to groundfish caught with fixed gear under the groundfish trawl IFQ program. The remaining balance was to be paid back through landings fees on Dungeness crab and pink shrimp, and those loans were nearly repaid as of 2016. The industry was given the opportunity to approve or reject the buyback program (and the assumption of liability to pay back the loan) after a reverse auction was held determining how many permits and how much associated catch history would be removed. The referendum passed with over 85% approval [15].

Similar to other buyback programs that were fully or partially funded by industry, this one was done in conjunction with an anticipated move to a catch share system. Although it would take another eight years before it was implemented, a control date for the future catch share program was set at the time of the buyback, indicating that quota allocations would be based on catch history only up to 2003. The control date was meant to eliminate the incentive to fish for catch history and provided the remaining permit holders with some assurance that their eventual allocations in a catch share system would not be affected if other vessels increased their catches in the interim. The catch share program was implemented in 2011 with an IFQ system for the shore-based components of the groundfish trawl fishery (including Pacific whiting) and Pacific whiting allocations to cooperatives for vessels delivering to motherships and for catcher-processors. Quota allocations for most species were distributed at no cost in proportion to vessels' shares of total catch histories from 1994 to 2003, excluding the catch history of the buyback vessels [16].[1] Thus the quota that would have been issued to the permits bought back in 2003 was effectively allocated pro-rata to the vessels that remained in the fishery. This quota is referred to hereafter as the "buyback quota" (Table 1).

Two alternative methods are used to evaluate whether the annual financial gains that accrued to the remaining fleet in the Pacific groundfish trawl fishery as a result of the buyback quota they received have been sufficient to cover the annual cost of servicing the loan during the period 2009–2014. First, we estimate the fleet-level annual net revenues (gross revenues minus costs other than costs of capital) associated with the buyback quota using comprehensive cost-earnings data for 2009–2014 collected from all participants in the catch share program. Second, we use quota pound (QP) prices to estimate the value generated by the buyback quota annually. QP is the annual form of quota, and QP prices are analogous to one-year quota lease prices and should reflect the expected profit or "rent" that fishers expect to generate with an additional pound of catch of a given species.[2] They also represent the opportunity cost of using QP to balance catch rather than selling the QP to another fisher. We compared these alternative estimates of financial gains to the industry to the costs of financing the buyback, both in terms of actual landings fees collected to service the loan and the average annual cost of repaying the 30-year loan as originally envisioned.

This study does not attempt to estimate potential industry net revenues in the absence of the buyback or the catch share program, nor does it attempt to project future net revenues. Thus, we cannot estimate the net effect of implementing the buyback and catch share programs on net revenues or other measures of profitability relative to what would have happened in their absence. However, the analysis does indicate that the average annual net revenues of vessels participating in the fishery increased after implementation of the catch share system and suggests that the incremental net revenues generated by the buyback quota likely exceeded the cost to the industry of financing it in the years since the catch share system was implemented though not in all years before the catch share program.

2. Methods

2.1. Estimating value of buyback quota based on cost-earnings data

The first method used to estimate the value generated by the buyback quota is based on the share of net revenues attributable to the buyback quota. The Pacific groundfish trawl catch share program consists of several distinct sub-fisheries that target different species or species complexes. Sub-fisheries were excluded if the catch was less than total QP available not counting the buyback quota (i.e., the non-

[1] For several overfished rockfish species, allocations were based on bycatch rates applied to target species allocations.

[2] QP prices are essentially unit rents for each species-output equal to that species' price minus its virtual price. Virtual prices at the optimum equal a product-specific marginal cost [17].

Table 1
Percentage of catch history removed by 2003 buyback (buyback quota %) and average quota pound (QP) utilization rates (2011–2014).

	IFQ species	Buyback quota %	Utilization %
Constraining target species	Pacific whiting	5.68%	94.0%
	Petrale sole	43.09%	95.0%
	Sablefish North of 36° N.	41.25%	93.0%
Non-constraining species	Arrowtooth flounder	46.76%	37.7%
	Chilipepper rockfish South of 40°10′ N.	18.04%	25.7%
	Dover sole	41.42%	31.1%
	English sole	35.40%	2.5%
	Lingcod	39.75%	17.4%
	Longspine thornyheads North of 34°27′ N.	41.58%	48.0%
	Minor shelf rockfish North of 40°10′ N.	35.24%	5.3%
	Minor shelf rockfish South of 40°10′ N.	23.05%	12.7%
	Minor slope rockfish North of 40°10′ N.	40.08%	21.5%
	Minor slope rockfish South of 40°10′ N.	29.89%	24.5%
	Other flatfish	30.23%	16.8%
	Pacific cod	46.59%	20.1%
	Sablefish South of 36° N.	32.23%	43.4%
	Shortspine thornyheads North of 34°27′ N.	40.41%	49.1%
	Shortspine thornyheads South of 34°27′ N.	0.00%	7.3%
	Splitnose rockfish South of 40°10′ N.	22.21%	3.4%
	Starry flounder	19.37%	1.3%
	Yellowtail rockfish North of 40°10′ N.	35.40%	29.4%
Rebuilding species, allocated according to bycatch to target species ratio	Bocaccio rockfish South of 40°10′ N.		12.1%
	Canary rockfish		21.7%
	Cowcod South of 40°10′ N.		10.7%
	Darkblotched rockfish		35.3%
	Pacific halibut North of 40°10′ N.[a]		29.8%
	Pacific ocean perch North of 40°10′ N.		38.6%
	Widow rockfish		45.5%
	Yelloweye rockfish		6.6%

[a] Pacific halibut is not a rebuilding species, but it was allocated using the same mechanism because there is a prohibition against retaining Pacific halibut caught in the IFQ Program.

buyback QP). The rationale for this is that in sub-fisheries that had surplus QP without including the buyback QP, the buyback QP did not, in practice, enable additional catch and therefore net revenues for the recipient quota holders.

Only four quota stocks – Pacific whiting, northern sablefish,[3] southern sablefish, and petrale sole – had catches that exceeded the non-buyback QP in at least one year 2011–2014 (Table 2). Any sub-fishery that caught significant quantities of those species was included in the analysis for all years where the catch of that species exceeded the total buyback QP. The sub-fisheries included are Pacific whiting for years 2011–2013, northern fixed gear (NFG) for years 2011–2014, southern fixed gear (SFG) for 2011 only, dover-sole-thornyhead (DTS) for years 2011–2014, and petrale sole-rockfish (PTR) for years 2011–2014. The Pacific whiting sub-fishery includes both deliveries to at-sea motherships as well as deliveries to shoreside processing facilities. The fishery targets only Pacific whiting with a very small amount of bycatch. The NFG and SFG sub-fisheries use fixed gear (pots or longlines) to target sablefish with very little bycatch. Unlike the mid-water and the fixed gear sub-fisheries, the bottom trawl sub-fisheries are both multi-species fisheries. The DTS trawl sub-fishery targets dover sole, longspine and shortspine thornyheads, and sablefish. The PTR fishery targets primarily petrale sole but also catches a variety of rockfish and other flatfish. Both of these sub-fisheries are prosecuted only north of 36° N latitude so that any sablefish catches come from the northern sablefish quota stock. Although we exclude net revenues from other sub-fisheries that did catch significant amounts of Pacific whiting, sablefish, or petrale sole, results show that the additional net revenues provided by these fisheries are relatively small and including them does not change the conclusions of the analysis (see Supplementary Appendix).

Table 2
Buyback quota pound (QP) utilization rates (2011–2014) for constraining target species. The buyback QP utilization rates were zero for all other quota categories. Utilization rates assume all non-buyback QP is used before any buyback QP is used.

IFQ species	Percent of buyback quota utilized			
	2011	2012	2013	2014
Pacific whiting	69%	23%	88%	0%
Petrale sole	84%	95%	81%	94%
Sablefish North of 36° N.	86%	77%	88%	80%
Sablefish South of 36° N.	57%	0%	0%	0%

Two measures of net revenue are calculated. The first is variable cost net revenue (VCNR), which is calculated by subtracting variable costs such as captain and crew wages and costs of fuel, supplies, ice, food, and bait, IFQ cost recovery fees,[4] and observer costs from gross revenues. The second is total cost net revenue (TCNR), which additionally subtracts annual fixed costs such as capitalized expenditures and expenses on maintenance, fishing gear, and equipment from VCNR.[5] The 5% landings fee associated with the buyback is not deducted from either VCNR or TCNR since the purpose is to assess whether the net revenues are sufficient to cover these loan repayment costs or, alternatively, the average cost of loan repayment.

Data to calculate net revenues come from two primary sources, the Economic Data Collection (EDC) program and state fish tickets. The EDC program is run by the National Marine Fisheries Service, Northwest Fisheries Science Center and collects vessel-level annual cost information from all vessels in the catch share program [18]. Ex-

[3] Sablefish caught north or south of 36° 10′ N latitude, though biologically the same, are attributed to different quotas stocks. The northern quota cannot be fished south of 36° N and vice versa.

[4] IFQ cost recovery fees are fees on landings not to exceed 3% of ex-vessel value that cover the additional management costs attributable to the IFQ program.

[5] Note that some off-board costs such as gear storage and administrative costs are not collected. Therefore, reported net revenue is an overestimate of actual net revenue.

vessel revenue by species, vessel, and gear type are obtained from state fish tickets through the Pacific Fisheries Information Network (PacFIN).

Revenues by sub-fishery are calculated by assigning each trip to a sub-fishery based on species-level ex-vessel revenue from fish ticket data. For example, if a shoreside delivery for a particular vessel had a mix of rockfish and Pacific whiting and the Pacific whiting landings accounted for the majority of the revenue, then all of the landings revenue for that delivery would be associated with the shoreside Pacific whiting sub-fishery [18]. This is done for all IFQ groundfish trips between 2011 and 2014.

In order to calculate the costs associated with each sub-fishery, annual costs collected by the EDC program were disaggregated to the sub-fishery level by allocating costs to the individual trips that were assigned to each sub-fishery. Annual costs are allocated at the trip level proportional to one of three measures: landings weight, ex-vessel revenue, or days at sea [18]. For example, if 75% of a vessel's ex-vessel revenue was generated by trips in the DTS trawl sub-fishery, then 75% of the costs for equipment would be attributed to that sub-fishery. The nature of the cost category determines whether the proportion of landings weight, ex-vessel revenue, or days at sea is used for the disaggregation.

To estimate the share of net revenues attributable to the buyback quota, total annual VCNR and TCNR for a given sub-fishery are multiplied by the fraction of catch history that was removed by the buyback for the primary fully utilized target species (Table 1).[6] This fraction is equal to the percentage of total QP that would have been allocated to the vessels that were bought out and was instead allocated free of charge to the remaining participants. For the Pacific whiting sub-fisheries, net revenues were multiplied by 0.0568, which is the proportion of Pacific whiting catch history bought out. In the Pacific whiting fishery, virtually all revenue is generated by whiting. Note that net revenue from the Pacific whiting fishery was excluded in 2014 when utilization of buyback quota was zero. For the SFG fishery, VCNR and TCNR are multiplied by 0.3225, which is the proportion of southern sablefish catch history purchased in the buyback. The SFG fishery catch is exclusively sablefish. SFG revenue is only included for 2011 when buyback quota was needed to cover total catch of southern sablefish. For the DTS and NFG sub-fisheries, VCNR and TCNR are multiplied by 0.4325, which is the proportion of northern sablefish catch history purchased in the buyback. Although the DTS sub-fishery is a multispecies fishery, the buyback percentage for sablefish is used rather than a weighted average of species caught in the DTS fishery since sablefish is the only species in the DTS fishery for which total catch exceeded the non-buyback QP. For the PRT fishery, VCNR and TCNR are multiplied by 0.4309, the proportion of petrale sole catch history that was removed in the buyback, again since petrale sole is the only target species in this sub-fishery with catch greater than the total non-buyback QP. Note that in these multispecies sub-fisheries, revenues from all species caught are included in VCNR and TCNR, not just sablefish and petrale sole.

2.2. Estimating value of buyback quota based on QP values

An alternative method to estimate the financial gains generated by the buyback quota for the quota owners that received it is to use QP values. Each year quota share (QS) owners are allocated quota pounds (QP) based on the share of total sector QP that their QS represents. QPs must be used to balance catches and can be traded, bought and sold during the year they are allocated (i.e., they have a one year duration).[7] QP prices are analogous to one-year lease prices. If the QP market is efficient, the QP price should roughly reflect the difference between the expected price of the fish and the expected cost of catching this fish on a per pound basis (or more accurately the ex-vessel price of fish minus the virtual price of the fish [17]. Even if this is not the case, the QP price should be indicative of what a vessel owner would have had to pay to purchase the required QP – or the price they could have sold their QP for instead of fishing it [19].

All QP transfers must be done through a web-based platform operated by the Northwest Fisheries Science Center. For cash sales, transferors are asked to put in the total value of the transfer. Total values and quantities from single-species cash sales are used to calculate weighted average QP prices. These prices are publicly available for species where there are at least two unique buyers and sellers in a given year (https://www.webapps.nwfsc.noaa.gov/ifq/). The value generated by the buyback quota each year is estimated by multiplying these QP prices by the quantities of QP that current permit owners received as a result of the buyback (total QP allocated times the buyback percentages shown in Table 1).

2.3. The cost of financing the buyback

The groundfish trawl fishery was originally responsible for repaying $28.4 million over 30 years with a 6.97% interest rate. The actual annual loan payments each year are based on a 5% fee on trawl-caught groundfish and vary substantially year-to-year. In addition to comparing incremental fishery net revenues to these actual landings fees, we explore three alternative scenarios with fixed annual payments, each with a 6.97% interest rate and the loan paid off by 2033 (the original loan terms). These scenarios provide a means to compare the financial gains accruing to quota owners with the average annual cost of financing the loan under alternative assumptions. Had the industry begun paying that loan in 2004 with a fixed annual payment (rather than a landings fees as was actually done), an annual payment of $2.28 million would have been required to service the loan (Scenario 1 in Table 3). However, because of a delay in getting the landings fee system in place, approximately $4.23 million of interest was added to the principal before the industry began to repay the loan. The landings fees collected between 2006 and 2010 averaged $2.24 million per year, which was sufficient to cover the interest on the loan but not to pay down the principal, which grew to over $32.5 million by the time the catch share program was implemented in 2011. Paying back the remaining principal by 2033 would require an annual payment of $2.88 million from 2011 to 2033 (Scenario 2 in Table 3). Finally, had the entire cost of the Pacific groundfish trawl buyback ($38.4 million) been financed by the industry, it would have required an annual payment of approximately $3.05 million per year to pay off the loan in 30 years (Scenario 3 in Table 3).

3. Results

Estimates of annual VCNR attributable to the buyback quota between 2009 and 2014 have substantially exceeded the fixed payment that would be required to finance the buyback loan (Table 3, Scenarios 1–3) as well as the actual landings fees paid by catch share participants in every year evaluated (2009–2014) (Table 4, Fig. 1). Annual VCNR attributable to the buyback quota also exceeded the fixed payment that would have been required to pay back the full cost of the buyback without a public subsidy (Fig. 1). Note that net revenue values in Table 4 and Fig. 1 reflect total VCNR attributable to the buyback quota as opposed to average values per vessel.

[6] Note that if a fishery showed a loss in TCNR in a given year, we count the same proportion of the loss as we would for a gain. Although we would not expect additional QP to increase a vessel's loss, the calculation of a loss or gain in TCNR in a particular year is influenced by the allocation of fixed costs across years, which is somewhat arbitrary. In this way, the total or average TCNR for the fleet over the six-year period is not influenced by the allocation of those fixed costs by year.

[7] The IFQ system does allow 10% of unused QP to be carried over into the next year, but not beyond provided that the aggregate carryover is not sufficient to enable catch above the acceptable biological limit.

Table 3
Fixed annual payments (millions of nominal dollars) necessary to pay back the cost of the Pacific groundfish trawl buyback under alternative scenarios using a 6.97% interest rate.

Loan/payment Assumptions		Fixed annual payment
Scenario 1	2004 Principal: $28.4 Million Length: 30 Years (2004–2033)	$2.28
Scenario 2	2011 Principal: $32.5 Million Length: 23 Years (2011–2033)	$2.88
Scenario 3:	Total cost: $38.4 Million Length: 30 Years (2004–2033)	$3.05

If TCNR is used to measure incremental financial gains attributable to buyback quota, the case is less clear. Between 2011 and 2014, TCNR attributable to the buyback quota would have been sufficient on average (over the 2011–2014 period) to cover the $2.28 million loan repayment under Scenario 1 but not the $2.88 million payment under Scenario 2 or the $3.05 million payment under Scenario 3 (Table 4, Fig. 1). During the pre-catch share period (2009–2010) and in 2012, TCNR would not have been sufficient to cover the payment under any of the fixed payment scenarios. TCNR was also lower than the actual buyback landings fees paid by catch share vessels in every year between 2009 and 2014 (Table 4, Fig. 1). However, the buyback landings fees collected each year from 2011 to 2014 have been higher than the amount needed to pay back the loan on the original schedule.

It is notable that the landings fees recovered from the Pacific whiting fishery have been well over half of the total fees levied on groundfish catches since 2011 and have averaged more than 5 times the TCNR attributable to the 5.68% of Pacific whiting catch history associated with the vessels purchased in the buyback (Table 4). In contrast, the TCNR for the non-whiting sector has generally exceeded the landings fees collected from non-whiting groundfish. Thus, the Pacific whiting fishery has effectively been subsidizing the buyback loan repayment for the non-whiting groundfish sector.

In addition to considering whether the cost of the buyback program exceeds the net revenues associated with buyback quota, it is important to also consider the impact of the buyback fee on individual vessel profitability, which is very heterogeneous. There is wide variation in net revenues across the fleet, with some vessels unable to remain profitable while covering the 5% buyback landings fees. The average annual ex-vessel revenue for the three lowest revenue vessels was $5000 (average of 2011–2014), but the average annual ex-vessel revenue for the highest three vessels was $2.2 million (Fig. 2). Before taking buyback fees into account, 7% and 22% of vessels had negative VCNR and TCNR in at least one year between 2009 and 2014,

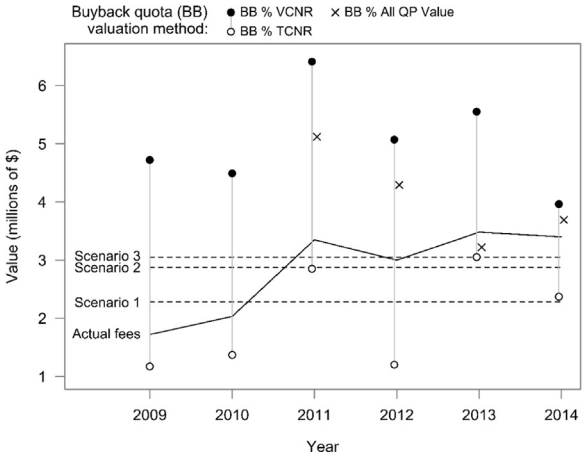

Fig. 1. Fixed annual payments necessary to pay back the cost of the Pacific Groundfish Trawl Buyback under 3 scenarios (dashed lines) (see Table 3 for definition of scenarios), actual buyback fees (solid line), and estimates of the value of buyback quota pounds (QP) using three methods: buyback quota (BB) % of variable cost net revenue (VCNR) (closed circle), BB % of total cost net revenue (TCNR) (open circle), and BB % of all QP value (×). These quota value estimates correspond with values in Tables 4 and 5.

respectively. Buyback landings fees represented 10.9% of VCNR (median) and 14.4% of TCNR (median) per vessel over the time period. There were only four instances where the VCNR was positive for individual vessels before buyback fees were deducted and negative after deducting them. However, there are 16 instances where TCNR was positive until buyback fees were deducted and negative after.

The costs included in calculating VCNR and TCNR do not include the costs of purchasing QP. While many vessels rely only on their allocated quota and thus do not pay for QP, others purchase QP, and some of those vessels may well be experiencing losses once those costs are deducted from net revenue. Those costs are a transfer to the owners of the quota - for every dollar of cost to a vessel purchasing QP there is a dollar of revenue going to a quota owner. While it does not make sense to deduct QP purchase costs from TCNR when evaluating whether the aggregate fishery net revenues are sufficient to cover the cost of the buyback, those costs are realized at the level of the individual vessel and do affect profitability of these individuals.

We used QP prices as an alternative way to assess whether the value generated by the buyback quota has exceeded the loan financing costs. The annual value of the buyback QP (QP prices*buyback QP volume) has exceeded the fixed annual payments that would be required to pay off the buyback loan (Table 3, All Scenarios) in every year from 2011 to 2014 (Table 5).

Table 4
Revenue, variable cost net revenue (VCNR), and total cost net revenue (TNCR) associated with buyback quota and total buyback fees[a] for whiting and non-whiting sectors of the groundfish trawl fishery from 2009 to 2014 (millions of nominal dollars).

Sub-Fishery	Financial measure	2009	2010	2011	2012	2013	2014	Average 2011–2014
Pacific whiting	BB % Revenue	0.53	1.08	1.97	1.71	2.16	0	**1.46**
	BB % VCNR	0.22	0.49	1.02	0.69	1.01	0	**0.68**
	BB % TCNR	−0.06	0.07	0.41	0.04	0.51	0	**0.24**
	Total Buyback fees	0.40	0.81	1.78	1.61	2.07	2.00	**1.86**
Non-whiting groundfish	BB % Revenue	11.73	10.61	13.11	11.40	11.68	11.07	**11.81**
	BB % VCNR	4.50	4.01	5.39	4.38	4.54	3.96	**4.57**
	BB % TCNR	1.23	1.29	2.44	1.17	2.54	2.37	**2.13**
	Total Buyback fees	1.33	1.21	1.57	1.39	1.41	1.40	**1.44**
All groundfish trawl endorsed	BB % Revenue	12.26	11.69	15.08	13.11	13.84	11.07	**13.28**
	BB % VCNR	4.72	4.49	6.41	5.07	5.55	3.96	**5.25**
	BB % TCNR	1.17	1.37	2.85	1.20	3.05	2.37	**2.37**
	Total Buyback fees	1.72	2.03	3.35	3.00	3.48	3.40	**3.31**

[a] Note that the buyback fees listed here are landings fees paid by catch share vessels only and are derived from the EDC data based on the vessels' fiscal years. Thus totals do not exactly match the total fees collected by the buyback program in each year.

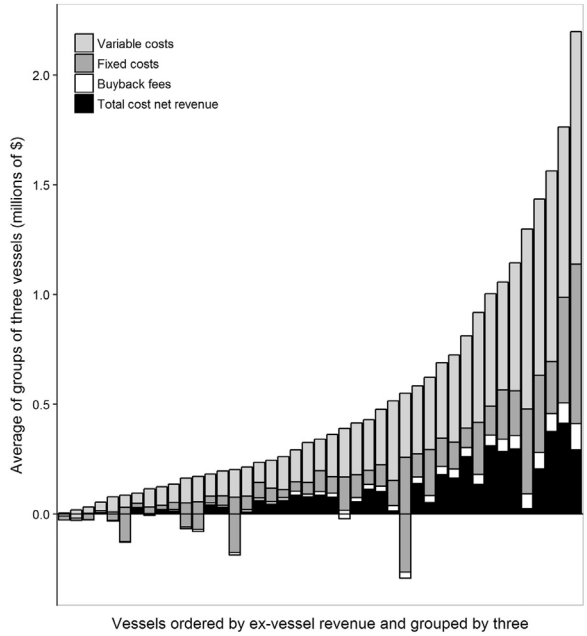

Fig. 2. Breakdown of total revenue for groupings of 3 vessels in the catch share program for 2011–2014 (number of vessels = 130) showing variable costs, fixed costs, buyback fees, and total cost net revenue. Vessels were averaged into groups of three to display the heterogeneity of participation levels while protecting confidential information.

Table 5
Estimated total buyback quota pound (QP) sale value (millions of nominal dollars) calculated as the buyback percent of value of all QP issued (BB % All QP Value). Actual buyback payments are provided for context.

Quota Species/ Group	Measure	2011	2012	2013	2014	Average 2011–2014
Pacific whiting	BB % All QP Value	0.37	0.51	0.74	0.68	**0.57**
	Buyback Fees Paid	1.78	1.61	2.07	2.00	**1.87**
Non-whiting groundfish	BB % All QP Value	4.75	3.78	2.48	3.01	**3.51**
	Buyback Fees Paid	1.57	1.39	1.41	1.40	**1.44**
All Groundfish	BB % All QP Value	5.12	4.29	3.22	3.69	**4.08**
	Buyback Fees Paid	3.35	3.00	3.48	3.40	**3.31**

Again we note that the actual repayment mechanism for the loan is a 5% landings fee, which has generated total buyback payments from 2011 to 2014 that exceeded the average payment amounts necessary to pay off the loan on the original schedule (Fig. 1). The average annual value of the buyback QP between 2011 and 2014 was higher than the average annual buyback fees paid, though buyback QP value was lower than buyback fees in 2013 (Table 5). While the average annual value of buyback QP substantially exceeded buyback landings fees for the non-whiting groundfish sectors, the opposite was true for the whiting sector (Table 5). Over the 2011–2014 period, the average value of whiting buyback QP ($0.57 million) was substantially lower than the buyback landings fees paid on whiting landings, which averaged $1.87 million.

4. Discussion

Squires [3] suggests that the Pacific groundfish trawl fishery buyback took the fishery from a situation of economic crisis to one of profitability during the years leading up to the catch share program. The buyback may have played an important role in generating agreement amongst fishery stakeholders to move toward a catch share system. It also provided a means for remaining vessels to finance consolidation of quota and thereby improve efficiency. Had the fishery simply moved directly to an IFQ system with no buyback program, remaining vessels would have had to privately secure financing to purchase quota from exiting vessels, and this may have been difficult and costly. Lenders are generally unwilling to finance the full cost of quota purchases, and, if they had, commercial interest rates would likely have been higher than those associated with the buyback loan.[8] This might have resulted in acquisition of quota mostly by larger firms with greater and cheaper access to capital – a result that was apparently undesirable given the fact that the Pacific Fishery Management Council set tight aggregation limits designed to prevent concentration of quota holdings by large firms.

Net revenues generated by the fishery after the buyback were almost certainly higher than they would have been were the buyback never to have happened and those vessels remained active, since total fixed costs would have been higher with a larger number of vessels. Consolidation and associated fixed costs savings might have occurred under the catch share program without a buyback through private sales of quota. However, this assumes the buyback vessels would have exited voluntarily, which is not always the case after IFQs are implemented, particularly when quotas are not limiting [20]. In any case, the consolidation would have been delayed at least eight years to when the catch share system was implemented. It appears that profitability increased further once catch shares were implemented. Our results show a substantial increase in TCNR in the four years after catch share implementation relative to the two prior years. Average annual TCNR for the non-whiting sector from 2011 to 2014 increased over 70% relative to 2009–2010. Vessel-level TCNR increased 120% from an average per vessel of $26,800 (2009–2010) to $58,400 per vessel (2011–2014) because the number of active vessels in the non-whiting sector steadily dropped from 119 in 2009 to 83 in 2014. TCNR in the whiting sector was approximately zero prior to the catch share program as a result of low annual catch limits, but increased from 2011 to 2014. We cannot be certain whether, or to what degree, the increase in TCNR after the catch share program was implemented was due to catch shares since we have not attempted to estimate what net revenues would have been in the absence of catch shares. However, it is clear that fixed costs as a percentage of revenue were substantially lower after catch shares were implemented due to further consolidation beyond what occurred directly as a result of the buyback. It is the reduction in fixed costs that is primarily responsible for the increase in TCNR for the non-whiting groundfish fishery. For the Pacific whiting sector, there was a large increase in gross revenues (more than double) fueled by increased annual catch limits and higher ex-vessel prices. Fixed costs increased, but not in proportion to revenue, so fixed costs as a share of revenue declined substantially for the Pacific whiting sector.

Since VCNR attributable to the buyback quota clearly exceeded buyback repayment costs while TCNR may not have, this raises the question of which measure is more appropriate for assessing whether the net financial gains that accrued to the industry as a result of the buyback were positive. This depends on assumptions about the effect of the buyback program on fixed costs at the vessel level. If only a small percentage of total catch history had been removed and consolidated on the remaining vessels, the additional quota and associated catch would not be expected to substantially increase fixed costs for the remaining vessels. In this case, the VCNR attributable to buyback quota would be the appropriate measure of value accruing to remaining vessels. However, since around 40% of the catch history was removed, we might expect that harvesting this much additional catch would lead to

[8] When the buyback loan was originated, interest rates were much higher than they have been in recent years.

some increases in fixed costs for the remaining vessels, though perhaps not in proportion to the additional catch enabled by the buyback quota. The fact that fixed costs as a share of revenue fell substantially after implementation of the catch share program (as a result of increased consolidation) supports the conclusion that fixed cost did not increase in proportion to incremental catch. Thus the appropriate measure of marginal benefits associated with the quota accruing to the remaining fleet is arguably between VCNR than TCNR. Assuming financial gains to the industry were equal to the average of VCNR and TCNR would suggest the benefits of the buyback to the remaining vessels have exceeded the cost of financing the buyback loan.

The valuation of the buyback quota using QP prices provides an alternative way to value the financial gains accruing to the remaining fleet that does not rely on comprehensive cost-earnings data (which are not available for many fisheries). Valuation based on QP prices theoretically might be expected to be more similar to VCNR to the extent that vessels are paying the marginal value of an additional unit of QP. In practice, the valuation using QP prices produced an intermediate valuation between VCNR and TCNR, which may suggest that at least some QP prices do not fully extract the margin between revenue and variable costs and leave some revenue to cover fixed costs. The average annual value of buyback quota has exceeded the average cost of financing the buyback (e.g., the fixed repayment scenarios 1 or 2) and the average annual buyback landings fee collected between 2011 and 2014. This strengthens the conclusions that the financial gains to the industry resulting from the buyback have exceed the costs of financing it.

Many members of industry argue that the costs of repaying the buyback loan (through the 5% landings fee) are too high, and that they cannot afford these costs. During the first four years of the catch share program, landings fees exceeded the overall TCNR associated with the buyback quota every year and landings fees exceeded even the QP valuation in 2013 (Fig. 1). This may indeed have created cash flow problems for some vessels; however, since landings fees collected each year between 2011 and 2014 have been higher than the fixed payment necessary to repay the buyback loan, the loan is being repaid ahead of schedule, which will reduce future payments. Alternatively, the landings fee percentage could be reduced in the future and still pay off the loan on time. When evaluating whether the remaining vessels benefited from the buyback, it is more appropriate to compare the increased net revenues accruing to them as a result of the buyback to the average cost of financing it, which is represented by the fixed payment Scenarios 1 and 2 (Fig. 1, Table 4). Note that, while the fleet overall may have gained from the buyback, not all remaining vessels shared equally in either the gain or the cost of financing the buyback, and some vessels may have been worse off as a result of the buyback and the associated requirement to repay its cost. This is particularly likely for new entrants that were not allocated any of the buyback quota.

The use of a landings fee to pay back the buyback loan has advantages but also creates asymmetry between those who benefit from the buyback and those who pay it back. The landings fee has the advantage that it may reduce risk to the industry, since payments are reduced when revenue falls. It also collects higher payments from catch share participants with higher revenues who may have a greater ability to pay. However, to date, the landings fees collected from the whiting sector appear to have exceeded the financial gains that accrue to them while the opposite is true of the non-whiting sector. Quota owners that sell rather than fish the QP allocated to them as a result of the buyback quota pay nothing toward loan repayment directly while the vessels that buy the QP and fish it pay landings fees. There are other funding mechanisms that might more equitably recover the costs of financing the buyback from those who benefit from it. For example, loan repayment might be financed with a fee on quota shares levied on quota owners.

5. Conclusions

This study suggests that industry funded buyback programs in conjunction with catch shares can provide net financial gains to the remaining fleet and provide a means of financing consolidation that does not disadvantage smaller firms with less access to capital. The analysis suggests that overall financial gains accruing to quota owners that received buyback quota probably have exceeded the average cost of servicing the loan in the years since the catch share system was implemented. Financial gains attributable to buyback quota may not have always exceeded the actual landings fees collected, but, when landings fees have exceeded the amount necessary to pay down the loan on schedule, they reduced future payments. We did not attempt to project future net revenues, but fish prices and revenues are likely to rise with inflation, while the loan principal is unaffected by inflation so the ratio of loan payments required to pay off the loan (e.g. the fixed loan payment scenarios) relative to gross revenue should fall over time. Thus it is it more likely that incremental financial gains attributable to the buyback quota will exceed loan repayment costs in later years. Notwithstanding the conclusion that the overall gains exceed overall financing costs for the quota owners who were allocated buyback quota and remained in the fishery, the use of landings fees as a repayment mechanism appears to have created winners and losers from the buyback. Designers of future buybacks may want to consider repayment mechanisms that more equitably balance benefits and costs across individuals, participant types, and sectors.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.marpol.2017.05.002.

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