

**A Critique of the Economic Analyses in the 2007-
2008 DEIS and the GAP**

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I. Executive Summary

The primary concern of this critique is to address the limitations of the economic methods used in chapter 7 of the 2007-2008 Pacific Coast Groundfish Fishery DEIS and the supplementary Groundfish Advisory Subpanel (GAP) report. In the second part of this critique we review some of the critical economic perspectives missing from the Pacific Fishery Management Council (PFMC) decision-making framework, mainly human welfare and economic benefits. Overall, meeting the goals of the PFMC to sustain the economic and environmental role of the Pacific Coast Groundfish fishery requires more advanced methods, broader economic perspectives, and a clearer representation of the existing data. Seeking to inform the PFMC public decision-making process we find in our review that:

First, the input-output (I/O) method underlying the economic impact assessment model used by the council is an inferior technique given other available methods, mainly dynamic econometric models. Econometric models can be easily and effectively applied to the existing datasets and can produce empirically grounded results. Comparatively, I/O models are *ad hoc*, have little empirical grounding, and are not effective in solving complex resource constraint problems. While the current analyses rely almost entirely on I/O impact estimates to measure policy performance, these numbers lack a connection to the economic payoff and tradeoff between the broader slate of policies regulating the Pacific Groundfish fishery.

Second, the issue remains that analyses in the DEIS repeatedly emphasize the economic pain of regulated periods by reporting the immediate impacts of reduced fishing, but these numbers say nothing of the benefits of rebuilding ocean fish populations. In addition to economic costs there are also benefits associated with the rebuilding measures, and all stakeholders are affected by the stock-rebuilding benefits and the ecosystem services accruing to the Pacific Groundfish fishery. Analyses which incorporate these economic values are urgently needed to shift the PFMC management protocol towards a sustainable fishery paradigm.¹

Third, the shifting assemblage of the Groundfish Fishery is a serious ecological side effect of traditional commercial fishery management.² These shifts are being amplified by competitive total allowable catches (TACs) and by regulations allowing the targeting of high value species.³ Historically, fishery management choices that have maintained competitive, effort creeping behavior have permanently hindered the ability of fish stocks to rebuild.⁴ We cannot disregard the economic costs associated with the negative externality of ecosystem decline.

¹ Pauly (2000).

² Levin, Phillip et al. (2005)

³ Grafton, R. Quentin et al. (2006)

⁴ Imeson (2006) and Roy (1996).

II. The limitations of I/O models

We begin by outlining some of the inherent problems with input/output (I/O) methods. In Chapter 7 of the DEIS there are at least four missing caveats regarding the interpretation of the Fishery Economic Assessment Model (FEAM) I/O estimations.⁵ First, I/O impact estimates are not representative of net changes in the economy. Second, I/O models cannot estimate resource efficiency/productivity. Third, results from I/O models are extremely volatile. By this we mean that extremely different impacts can be estimated with a slight adjustment of initial assumptions. Fourth, the static nature of I/O models makes it impossible to project economic payoff into the future.⁶

The first caveat is the most critical one. Impact estimates can be very misleading; because of this they require careful interpretations. The challenge for I/O models is that they assume, *ceteris paribus* the pathway for all labor and capital in the economy is to and from an unemployed state. Like a light switch being turned on and off, I/O models assume that all inputs have only these two relative positions. In reality, a great portion of labor and capital is mobile (able to move across industries within an economy). Since exiting the economy is not a final position for all labor and capital, impact estimates far overstate the gains or losses associated with an impact. Realistically, I/O impact estimates are better indices of the volume of mobilized capital and labor than of net effects on the economy.

To explain the second caveat we consider why productivity is important. Imagine the difference in total landings and revenue earned by the most productive fishing vessel in a fleet, versus the least productive. Now consider the difference in the size of economic loss that would occur from removing each of these ships from the economy. A boat which is employed as frequent as possible and is guided by experienced fishermen will be much more productive in terms of landings and revenue than a part-time vessel with lesser experienced fishermen, hence removing the more productive ship would create a significantly greater impact. Yet, given this very obvious suggestion, to an I/O model removing either vessel is exactly the same in terms of impacts. This lack of distinction in the quality of inputs makes it very difficult for these models to keep a good accounting of real impacts.

In I/O models there is a need to identify leakage. Leakage is the fraction of a dollar that seeps out of a regional economy every time it is traded. Within a model, leakage is determined by a number between 1 and 0. This number represents a critical initial assumption and can turn out vastly different impacts. The sensitivity of I/O models to numbers like this make them vulnerable to exploitation by the modelers. It would be quite easy to adjust something internal to an I/O in order to make a result look much different.

Last among these caveats is the inability of I/O models to track events over time. We will discuss this caveat in detail later.

⁵ Milton (1993), pp. 1178-1179, and James (1994), pp. 104-106.

⁶ These caveats also apply to, but are missing from, the analysis in the supplementary GAP report.

Another important concern is that I/O models make the assumption that inputs are endless, forming a linear projection of prices and wages through time. By restricting curvature, these models reject the notion of economies and diseconomies of scale and remove the concept of scarcity from the consumption of natural resources. In reality, there are significant shifts in the market and non-market value of natural resources as they become scarcer. I/O models are blind to these effects and thus make a poor model choice in deciphering natural resource markets.

Beyond these general points, there exists a specific problem with FEAM's I/O estimates. Appendix D of the 2005-2006 informs us that the FEAM model uses IMPLAN's 1998 national industry coefficients and transaction tables. IMPLAN's datasets are generated using a top-down approach that starts with a set of national average transaction coefficients (records of firms buying and selling of inputs). These IMPLAN coefficients are not likely to reflect the real production functions of firms in the Pacific Coast Groundfish Fishery because they are not region specific and come from a different decade where landings, exvessel sales, and on-shore production were much larger. These outdated national industry coefficients will instill an upward bias on current impact estimates. This means IMPLAN will overestimate the size of economic impacts from reduced fishing. While FEAM provides a simple account of events, forecasts generated from IMPLAN's 1998 national dataset are likely to be very distant from the dynamic reality of the Pacific Groundfish industry.⁷

Overall, I/O models do not provide the appropriate perspective for making decisions regarding the Pacific Groundfish fishery. Using this kind of analysis to decide the fate of a fishery would be the equivalent of buying a home based solely on a realtors listed price. Without incorporating a spread of other information, I/O impact estimates remain disconnected from real changes in the economy and the goals of a sustainable fishery. Even if the estimates of the regulation impacts were accountable, this type of analysis is far too narrow.

To measure the net change in an economy as a result of an impact we need more information, and more than a static I/O model. Gauging the performance of various rebuilding alternatives requires an econometric model with an index for efficiency/productivity. At the aggregate level, such an index will allow regulators to determine the maximum market value of each fish stock and select more environmentally sustainable methods of maintaining revenues.

Initially, to get this number we have to know more about the production functions of firms in the industry. This knowledge can be gained through direct firm-level samples regarding buying (capital and labor) and selling (fish).⁸ In addition, demographic information such as age, education level, and job experience can help modelers determine realistic labor movements amidst new regulations. Once the index is made available it can be used with a dynamic (time series) representation of alternative resource

⁷ In the very least, FEAM should be updated to 2002, the most recently published IMPLAN dataset.

⁸ Though we are not endorsing the use of IMPLAN for fishery management purposes, we can provide an example of what this data would look like using IMPLAN's national transaction tables.

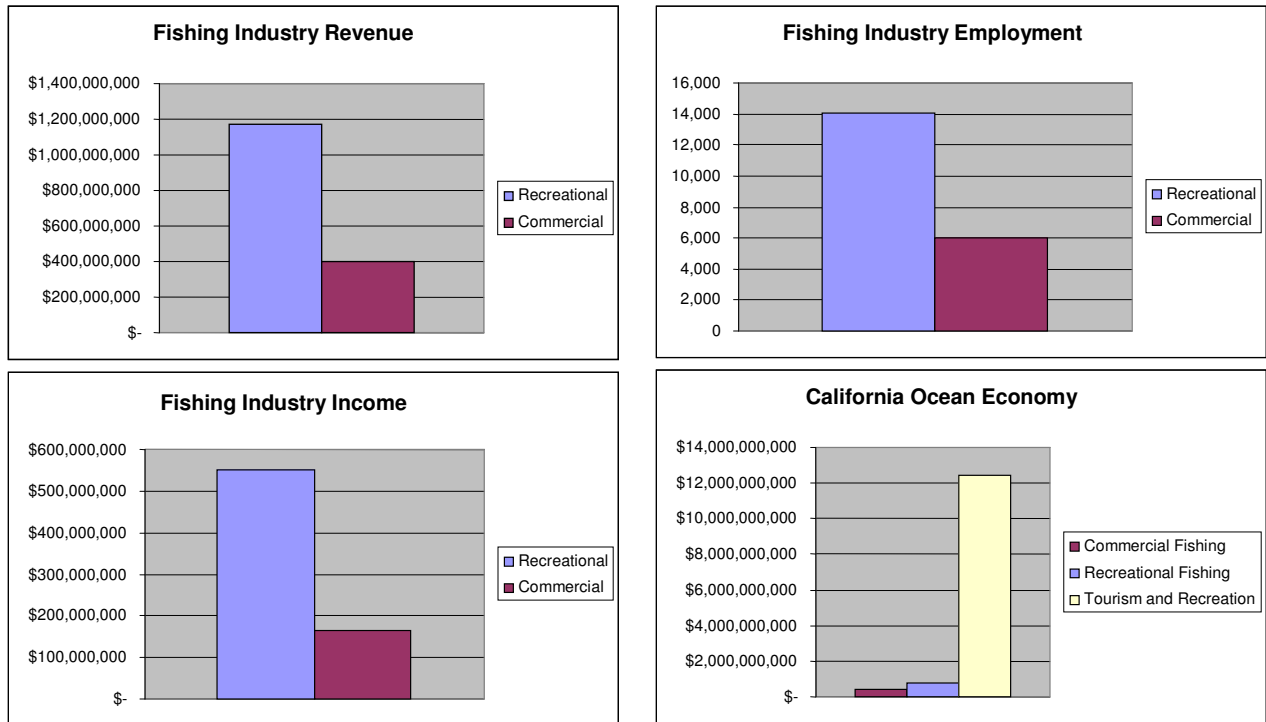
allocations. The results of which will provide a more meaningful picture of the economic effects of competing proposals for optimal yield (OY) catch levels.

We can demonstrate a measure of efficiency with a relevant example using California's Ocean Economy data from Kildow (2005). In this dataset, the commercial fishing sector represents the combined fish hatcheries and aquaculture, fishing, and seafood processing sectors. In 2000, there were significant differences between commercial and recreational fishing industries. In *figure 1* we show that compared to the commercial fishing sector, recreational fishing activity was substantially larger in revenue, income, and employment.⁹

Using this dataset we can now make a basic comparison of the ratio of labor to output. In *table 1* we roughly determine the increase in marginal productivity of labor (MPL) of a worker who shifts from the commercial fishing industry into the recreational industry. The data estimates income will increase \$11,584 for workers who shift sectors; marginal productivity will increase \$16,087, and for each five workers who shift to the recreational industry an additional job will open in the economy. We expect that if this data accounted for the non-formal labor pool in commercial fishing, these productivity increases would be much greater.

⁹ One critical perspective here is that commercial fishing represents a very small section of the Ocean Economy of California. It is unlikely to foresee "disastrous" economic impacts stemming from an industry that represents less than 2% of the oceanic gross state product (GSP).

Figure 1. California's Recreational and Commercial Fishing Industry



*source Kildow (2005)

If an initial impact, say a lowered OY on a specific rockfish species, reduced the number of workers in the commercial industry, the net change in the economy would not accurately be reflected by an I/O estimate. If some percentage of labor shifts into the recreational fishing industry, this would adjust the net revenue balance sheet. This scenario could potentially lead to a positive net change if the summation of labor and capital efficiency/productivity changes is greater in magnitude than the initial impact. The main point of this example is to illustrate that a major error in I/O estimations comes from the inability to track these industry tradeoffs.

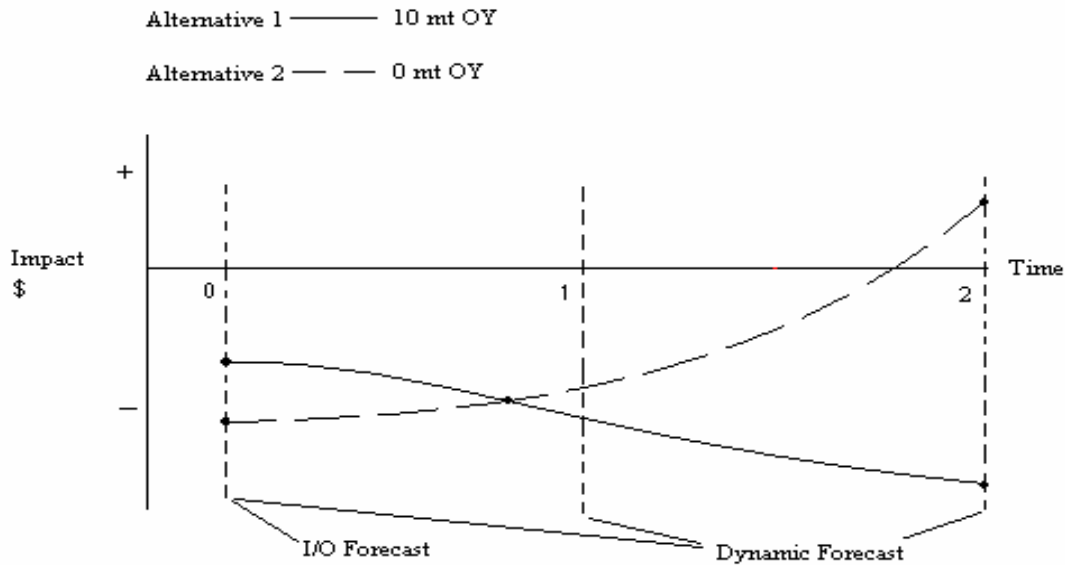
Table 1. California's Recreational vs. Commercial Fishing Industry in 2000.

	Recreational	Commercial	(Rec. – Com.)
Direct Impacts			
Revenue	\$1,170,862,000	\$403,284,093	\$767,577,907
Income	\$551,683,000	\$165,933,760	\$385,749,240
Employment	14,084	6,015	8,069
Average Wage	\$39,171	\$27,587	\$11,584
MPL	\$83,134	\$67,046	\$16,087
Employment Multiplier	1.6	1.4	0.2
Indirect and Induced Impacts			
Revenue	\$764,362,000	\$309,722,183	\$454,639,817
Income	\$314,763,000	\$125,877,350	\$188,885,650
Employment	8,258	2,490	5,768
Total Impacts			
Revenue	\$1,935,224,000	\$713,006,276	\$1,222,217,724
Income	\$866,446,000	\$291,811,110	\$574,634,890
Employment	22,342	8,505	13,837

**source Kildow (2005)*

Finally, we need to discuss why dynamic econometric models represent a major improvement over the I/O technique. Foremost, econometric modeling is a well established practice in the economic analyses of many agencies including the United States Department of Agriculture (USDA) and the Federal Reserve Bank. Econometrics is a practice that is completely based in statistical inference from empirical data. In *figure 2*, we illustrate how the goal to select an optimal action alternative would be made more tangible using dynamic econometric forecasts. I/O models estimate the first point of these curves which, depending on the sustainability of a selected OY catch limit, may or may not represent the optimal alternative. A dynamic model would instead forecast future payoff of action alternatives at different points in time. In a later section of this critique we present some of the evidence for upward and downward sloping payoff curves depicted by alternative 1 and 2 respectively.

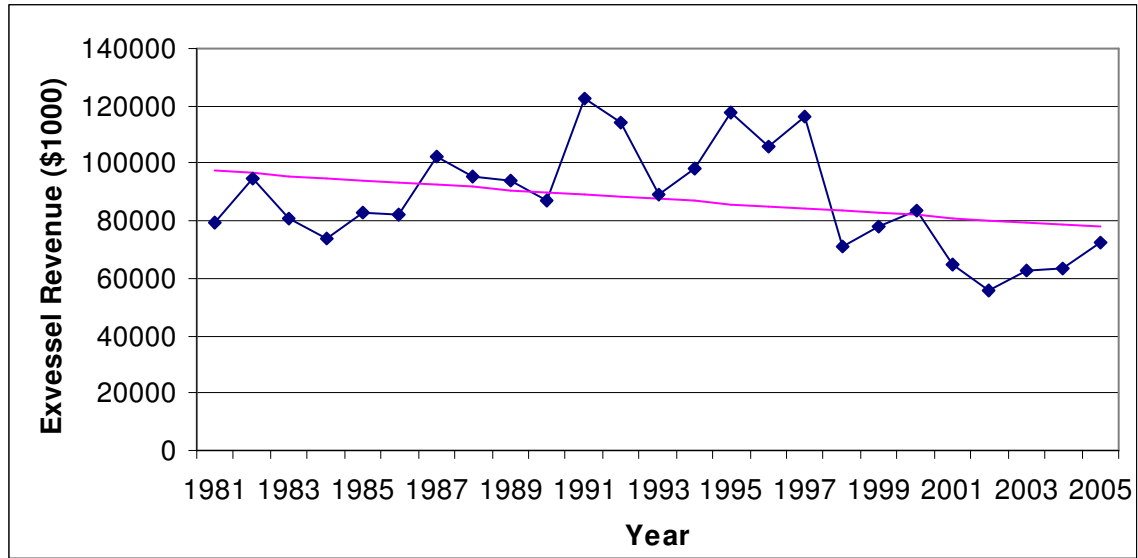
Figure 2. Economic Payoff Paths for Action Alternatives



There are other characteristics of time series models which make them more appropriate for the sequential management of a fishery. While there is nothing truly empirical about I/O estimation, observations of real before-and-after economic changes are precisely the opposite. This type of comparison can be made in a relatively simple time series procedure where a single change in regulation is tracked via economic performance of a specific coastal region. The observations have to be made directly through counts of employees, vessels, trips, wages, and exvessel revenue; or indirectly through firm entry, or exit. Then basic time series regression analysis can be used to decipher the unique economic trend correlated with the adoption of a specific regulation. These sorts of empirical observations will provide a more realistic impression of the impacts related to fishery management decisions.

In *figure 3* we exemplify this type of observation with the trend in aggregate exvessel revenue for the Pacific Groundfish Fishery. The annual real growth (accounting for inflation) in aggregate revenue over the last 24 years is negative at approximately -\$812,000. We have discussed why I/O impact estimates will not be able to forecast this trend. Still, real impacts which have had a net effect on the commercial industry appear in this data as variances from the trend line. These variances indicate shocks in annual commercial revenues, and likely reflect a combination of changes in ecological factors (recruitment rate, climate), market structure and prices, and regulation. Even if I/O models were able to predict OY impacts, shocks to the revenue stream come from many endogenous and exogenous influences which remain outside the I/O framework.

Figure 3. Exvessel Revenue from the Pacific Coast Groundfish Fishery



**source PacFIN*

A dynamic commercial industry model, capturing changes in efficiency, could be augmented to include various endogenous and exogenous shock variables. Adding this sort of complexity to a predictive model of a fishery market is necessary because of the wide array of possible influences.

To summarize, currently there are alternatives to I/O models. Applying a time series technique to the analysis of the commercial fishing industry would improve forecast reliability and the overall PFMC management strategy. A more sophisticated model would accomplish this by avoiding the static framework of I/O models, applying a measure of efficiency to industry inputs, and forecasting with the possibility of shocks occurring to the system.

III. Benefits from Rebuilding Fish Stocks

Aside from section 7.1.4.2.6 the discussion of economic benefits is neglected in the DEIS. In this next section we provide some examples of how these perspectives can be incorporated, and used to build a more inclusive management framework.

Planning for optimal use of any fish stock requires an assessment of the benefits gained from future fishing opportunity and the associated non-use values. Though we will discuss the use and non-use value benefits of rebuilding fish stocks individually, these values sum into a total economic value.

i. Use value benefits

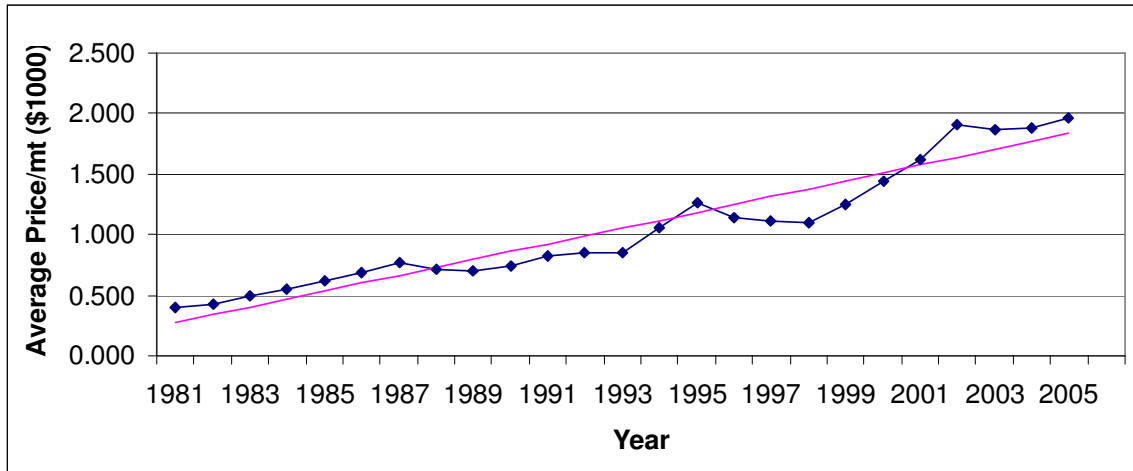
Fundamentally, oceanic fish are a form of natural capital and a vital national asset. To our commercial and recreational industries, to the public, and to future generations these oceanic fish stocks have immense values. From society's perspective, maximizing our return from these resources depends on the length of time in which we sustain them. The reason for this is that overtime the values of our fish stocks increases by way of human population growth. Assuming that growing populations continue to want to eat fish, the amount of fish society will desire caught tomorrow is greater than the amount we desire caught today.

Yet our present demand for fish already suffers from a tremendously reduced supply. Like other natural resources, fish stocks exhibit scarcity. Markets demand more fish be caught from this fishery than actually exist. Even though we cannot significantly alter this demand we can maximize our economic gains by rebuilding the stock to a sustainable level so that across generations, an increasing demand can be matched with a consistent supply.¹⁰

A sustainable fishery is not only an ethical goal, but an economic one as well. One way to see this in more detail is by viewing each of our fish stocks as an investment asset with significant rates of return. Protecting the resource in year t_1 can return more in market value in time t_2 than withdrawing from it in both t_1 and t_2 . For instance, consider the 24 year price trend in Rockfish in *figure 4*. The price for a metric ton of rockfish has increased at a rate 3% over inflation. Simply stated, Rockfish are a growth asset.

¹⁰ The same point can be made with the Groundfish non-market values.

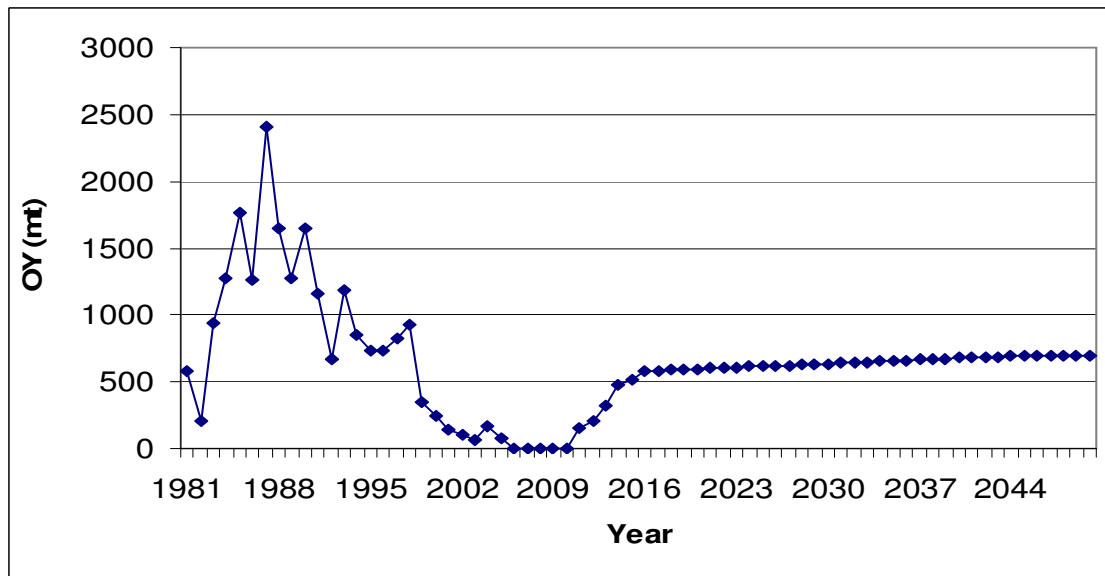
Figure 4. Average price per metric ton of Rockfish



*source PacFIN

There are more sophisticated methods to map out the benefits of rebuilding fish stocks. Sumaila (2005) provides a straightforward method for estimating exact benefits. Following this method, we formulate revenue streams from rebuilding a fish stock of critical Pacific Groundfish species. In *figure 6* we identify the 2007-2008 OY rebuilding plans for Darkblotched Rockfish.

Figure 6. DEIS 2007-2008 Rebuilding plans for Darkblotch Rockfish

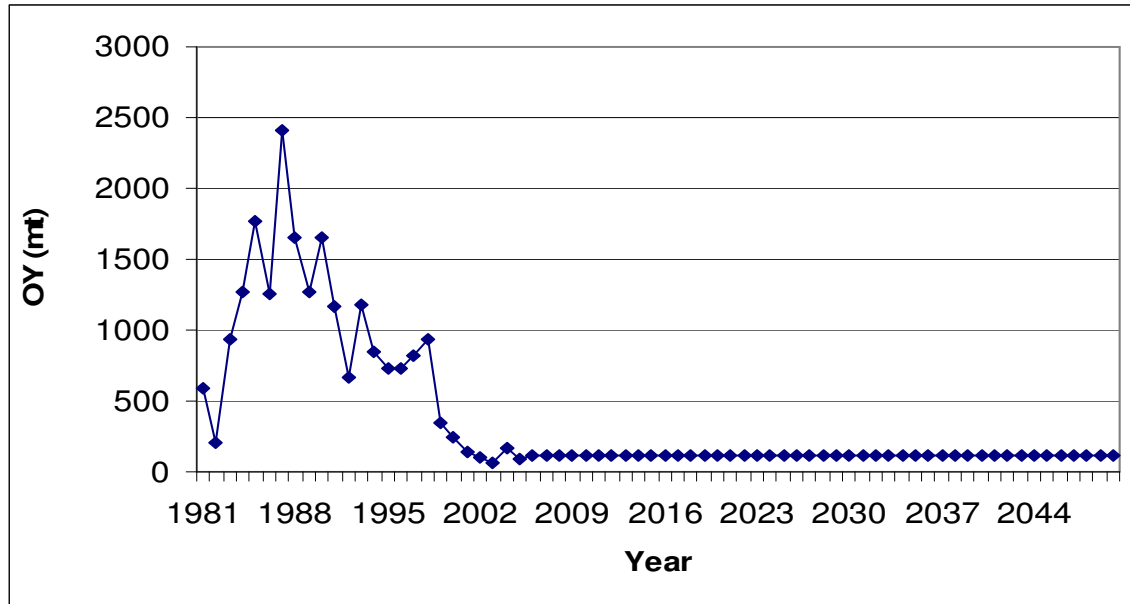


*source PacFIN and 2007-2008 DEIS.

From the end of 2006 to 2040, we estimate the direct use-value of these projected OY levels for Darkblotch at \$46,969,220. We estimate the net present value (NPV) over the same time period to be \$10,373,000. The difference between these values comes from the application of an inflation-based discount rate in the computation of the NPV.

We can now consider an alternative to the rebuilding scenario where fishing activity remains at level similar to current catch levels. This scenario, presented in *figure 7* represents the maximum allowable catch given a permanently diminished stock.

Figure 7. Permanently diminished stock for Darkblotch Rockfish



*source PacFIN and 2007-2008 DEIS.

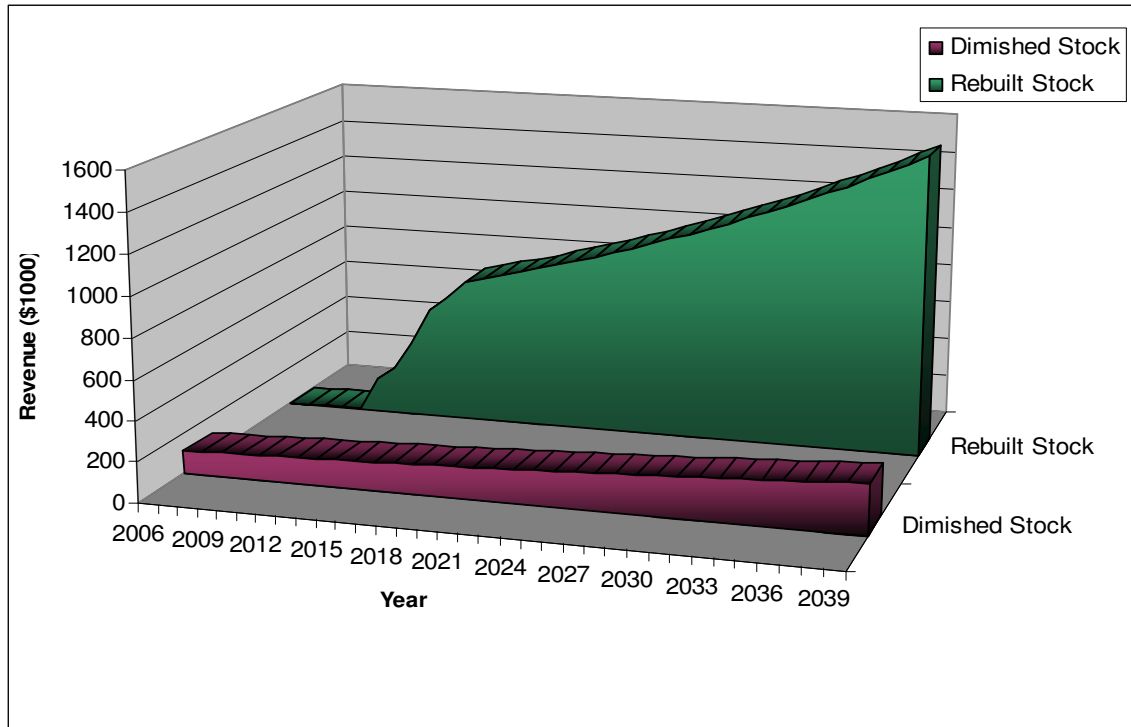
From this scenario, which replicates average catch and bycatch over the last 5 years, we estimate a direct use-value return of \$8,893,000, and a net present value of \$2,354,000. Hence, the NPV loss of failing to rebuild the Darkblotch population is estimated at \$8,019,000, or in other words, rebuilding is Darkblotch is worth \$8 million!

To visualize the tradeoff in these alternative scenarios we map their direct use-value and net present value in *figure 8* and *figure 9* respectively. The total value is represented by the area under each of these curves. In *figure 9*, the receding slopes are a product of discounting. As the rebuilt stock scenario for each graph depends critically on strong recruitment of Darkblotch from 2006 to 2010, the 0 OY pain period identifies the action alternative which captures the highest value. One note here is that the upward sloping section of the rebuilt stock payoff curve reinforces our point regarding *figure 2*, where a lower OY induces a much higher payoff in a short amount of time. Overall, it is clear that the direct use-value and NPV of a rebuilt Darkblotch stock more than compensates the opportunity cost of the 0 OY pain period.

One additional complexity which is not incorporated into this example is the cost of risk associated with catch levels nearing unsustainable levels. If in the current state of emergency, Darkblotch are caught at levels which inhibit their ability to reproduce, there exists a corollary risk of stock collapse. By collapse we mean the breach of the safe minimum standard of the species. Such an event would remove all use and non-use value from payoff streams hence forward. The risk of this event, in and of itself, represents an economic cost. This cost is, in fact, incurred every year where unsustainable fishing is

pursued. In the diminished stock scenario, the incorporation of the cost of risk would lower the payoff curve each year by an increasing amount.¹¹ While we cannot be precise about how safe rebuilding plans are, it is certainly the case that more risk would be assumed by continued fishing. Hence, including this complexity only increases the gap between these two payoff curves.

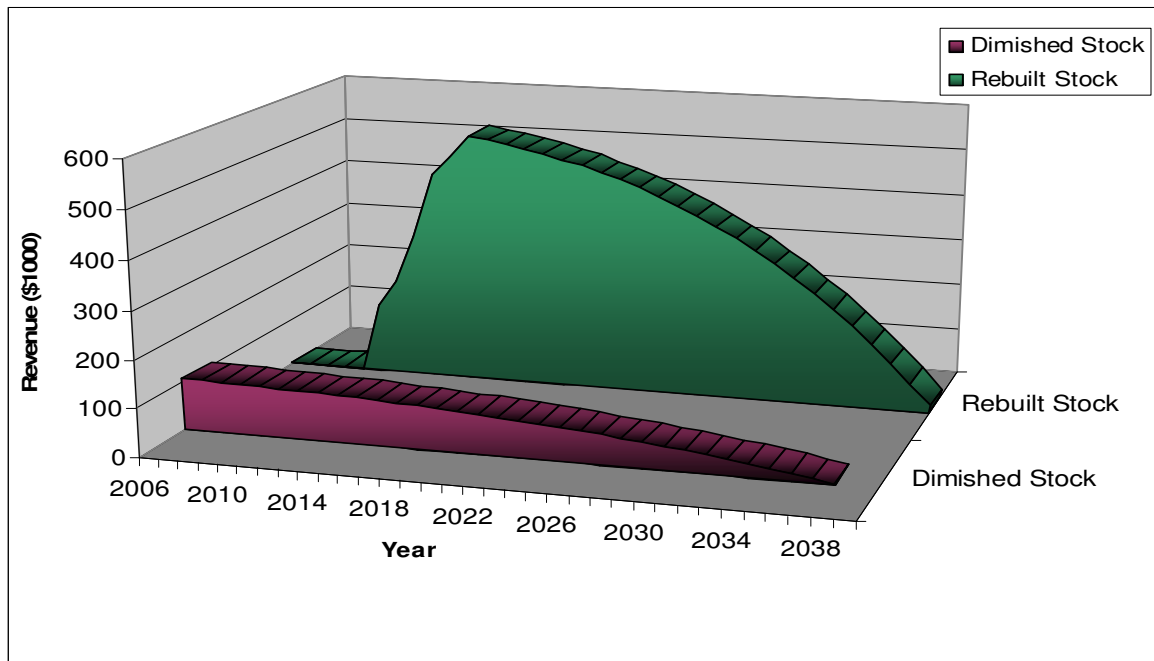
Figure 8. Direct Use-value for Landings of Darkblotch Rockfish



*source PacFIN and 2007-2008 DEIS.

¹¹ This is due to compounding of risk each year.

Figure 9. Net present value for Landings of Darkblotch Rockfish



*source PacFIN and 2007-2008 DEIS.

The numbers here represent the revenue stream gained directly from the sales of Darkblotch Rockfish. The main point of this example is to demonstrate the sizeable magnitude of the benefits that stem from a rebuilt species stock. In finalizing this point, it is critical to note that the same results from this example can be demonstrated using other species of Pacific Groundfish.

ii. Non-use value benefits

Now we turn to a short discussion regarding the non-use benefits of rebuilding the Pacific Groundfish fishery. A critical step required for this economic perspective is the identification of ecosystem services provided by the Pacific Groundfish fishery. An introductory list of ecosystem services is shown in Farber (2006). We can truncate this list to specifically identify services of the Pacific Groundfish fishery.

Table 2. Groundfish ecosystem services.

Ecosystem service	Amenability to economic valuation	Most appropriate method for valuation
Nutrient Cycling	Medium	Avoided Cost, Contingent Valuation
Nutrient regulation	Medium	Avoided Cost, Contingent Valuation
Biological regulation	Medium	Avoided Cost, Production Approach
Food	High	Market Pricing, Production Approach
Recreation	High	Travel Cost, Contingent Valuation, Ranking
Aesthetic	High	Travel Cost, Contingent Valuation, Ranking, Hedonic Pricing
Science	Low	Ranking

*Adopted from Farber (2006)

Farber (2006) aligns each of the ecosystem services with a rating of amenability to economic valuation and the corresponding method of valuation. With this type of procedural outline, economic research on the Pacific Groundfish fishery can focus on estimating the more plausible values.¹²

Hall (2002) contains a pertinent example of this type of research. The results of this paper indicate that there are measurable economic values associated with upkeep of California's coastal ecosystems. While this paper identifies willingness to pay in relation to efforts to adopt marine protected areas, a similar contingent valuation study could be conducted to determine the unique recreation/aesthetic value of the Pacific Groundfish assemblage.

Without actually performing this research it may be possible to extrapolate some meaning of the values estimated in this study as they relate to Pacific Groundfish. If we invent a binomial index for beach areas along the Pacific Coastline, which informs us whether or not a healthy assemblage of Groundfish exist in the nearshore area, we could roughly estimate the total recreational/aesthetic value of the Pacific Groundfish fishery.¹³ Designating a percentage of the \$3.6-\$4.8 million figure estimated in Hall (2002) to represent the value of keeping healthy stocks of Groundfish along a mile of beach, we could infer the amount of damage caused by reducing stocks beyond some eco-threshold. Using the binary variable, we could then aggregate the damage caused over a year as the total number of beach miles converted to unhealthy stocks times the average value of a healthy stock along a beach mile.

There is also a potential for studies which measure the value of the nutrient cycling and regulation. These types of studies would be more technical, however, because they require a biometric calculation of the ratio of Groundfish biomass which supports additional regions of the oceanic food chain. Nevertheless, there is an urgent need for this type of research because of the significant impacts ecosystem decay has on all stakeholders. We outline some of these impacts in the next section.

¹² For further clarification of the general methods listed in this table see James (1994) or the NOAA Coastal Ecosystem Restoration webpages: <http://www.csv.noaa.gov/coastal/economics/envvaluation.htm>
<http://www.csv.noaa.gov/coastal/economics/methodsenvvaluation.htm>

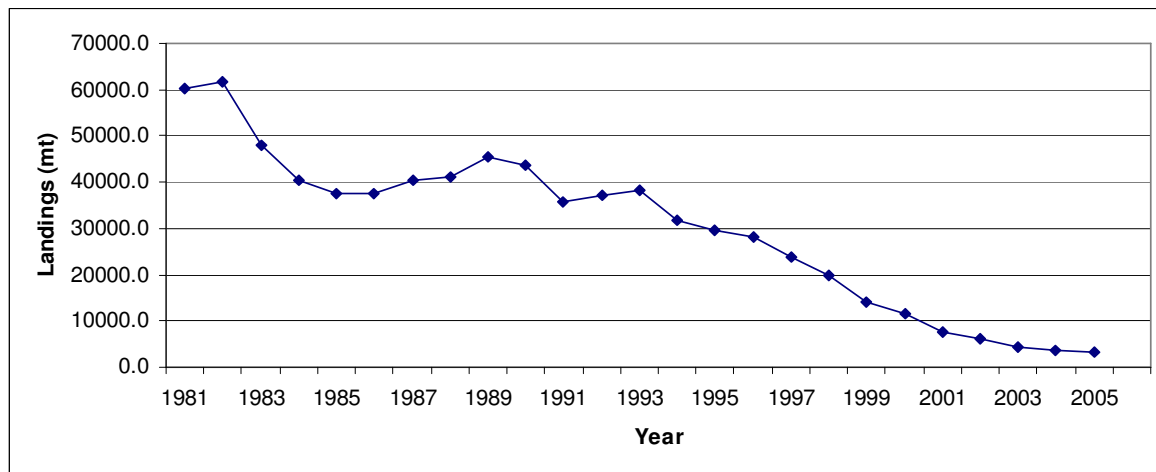
¹³ The total value estimated would not be as important or meaningful as the estimate of the economic damage brought on by over-fishing.

IV. The Externality of Shifting Assemblage

This section of the critique reveals some of the statistics regarding the shifting assemblage of the Pacific Groundfish fishery. Following our presentation of these statistics we discuss some of the potential economic implications of these ecological shifts.

First, we use PacFIN data to show some of the recent trends in the Pacific Groundfish assemblage. The most devastated group among the Groundfish is Rockfish. *Figure 10* portrays the decline in catch of Rockfish which has occurred since 1981. The 2005 catch level of Rockfish is a mere 5% of the levels harvested in 1981 and 1982. In other words, we have reduced the fished portion of the aggregate Rockfish stock by 95%.¹⁴

Figure 10. The Diminishing Stock of Rockfish in the Pacific Ocean

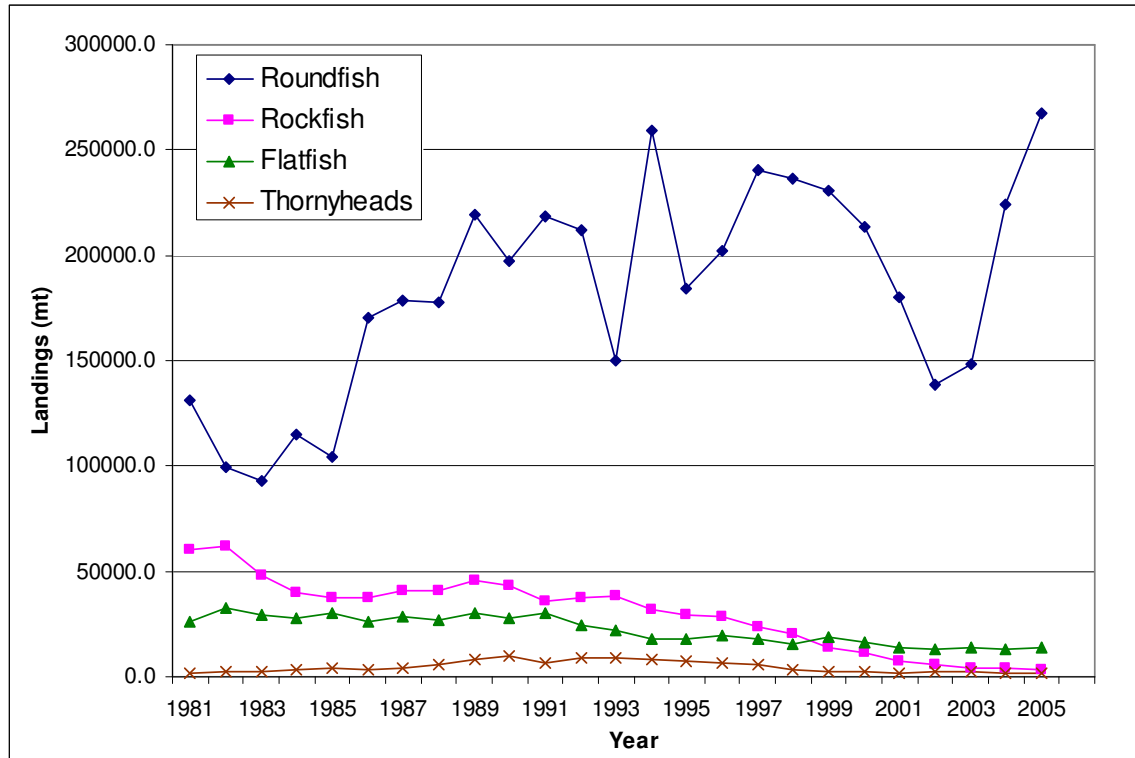


*source PacFIN.

How does this trend compare to other species in the Groundfish assemblage? This trend is similar in many species, but not all. In the recent history of the Pacific Groundfish fishery we find that the landings in the Roundfish group have predominantly expanded while most others have contracted. This group-by-group comparison is displayed in *Figure 11*. Assuming catch levels have a direct correlation to biomass, there is reason to believe this graph emulates the actual ecological shifts occurring along the Pacific Coast.

¹⁴ We make this point using landings data. While the link between actual biomass and landings is somewhat convoluted, a similar point can likely be made using the time series data of biomass estimates in the stock assessment over the same time period.

Figure 11. Pacific Groundfish Landings by group



*source PacFIN.

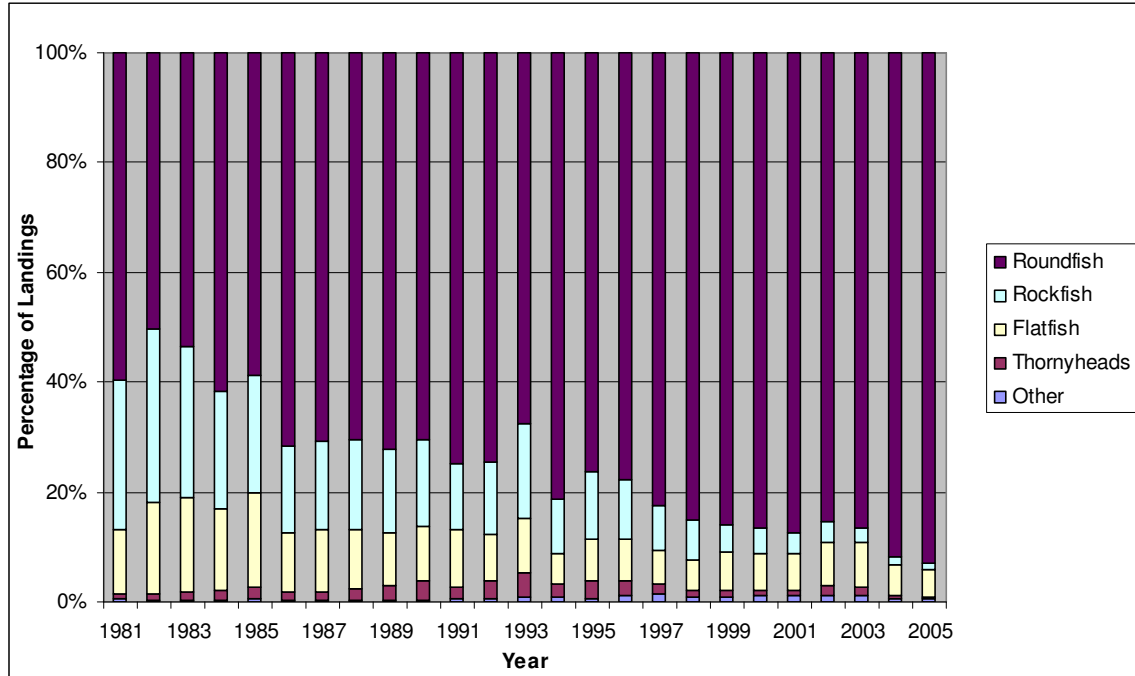
To bring this externality into the DEIS economic analyses we need to first highlight the evidence establishing the link between over-fishing and ecological decay. Research from a wide range of sources supports the theory that over-fishing is the primary cause of shifting assemblage. Most notable among these studies are the Levin (2005), Pauly (2000), and Grafton (2006) papers.

The Pacific Groundfish fishery is one more definitive example of this relationship, and so it is critical that these ecological impacts be brought to bear in the decision-making framework. To do this we have to identify which stakeholders are negatively affected by a change in the aquatic ecosystem and the magnitude of the economic losses associated with shifts in the assemblage.

To some extent all stakeholders are affected, as a fishery inhibits the properties of a public resource. Stakeholders within the market are affected by the reduction in the diversity of their operations. A smaller portfolio of fish to catch means overall that there are fewer economic opportunities to pursue. Mono-ecology or single-species fishery markets are also more prone to the biological shocks. If something happens to the staple species or group of species, the market will be left completely vulnerable. This is exactly analogous to financial investments where conversely a diverse portfolio establishes a safety net from high risk stocks. Stakeholders external to the market are equally harmed by reduced bio diversity, some of these harms we have already discussed as the values associated with ecosystem services.

The numbers relating to the shifts of the Groundfish fishery market tell an unsurprising story. In *figure 12* we compare the percentage of market landings represented by each group of groundfish species. In 1982, roundfish represented only half of the total landings in the Pacific Groundfish fishery. In 2005, roundfish provided 94% of the total biomass harvested. This is a clear shift towards a mono-ecology fishery.

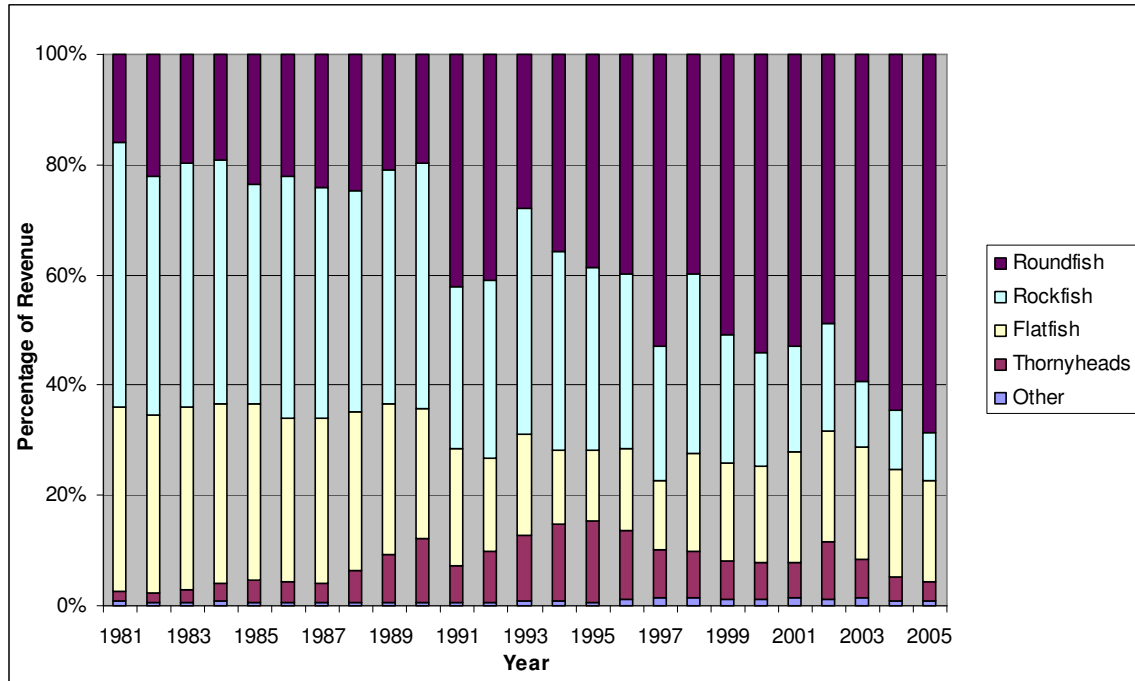
Figure 12. Percentage of total landings of Pacific Groundfish by group



*source PacFIN.

In the same gap of time the share of market revenues generated by each group of species has shifted. In *figure 13* we show that simultaneous loss of revenues from the decimation of Rockfish, and the equivalent gain from fishing more Roundfish. Today, three of every four dollars earned from the catching Groundfish represents a sale of Roundfish. Two decades prior, less than one in five dollars came from the same source.

Figure 13. Percentage of total revenue from Pacific Groundfish by group



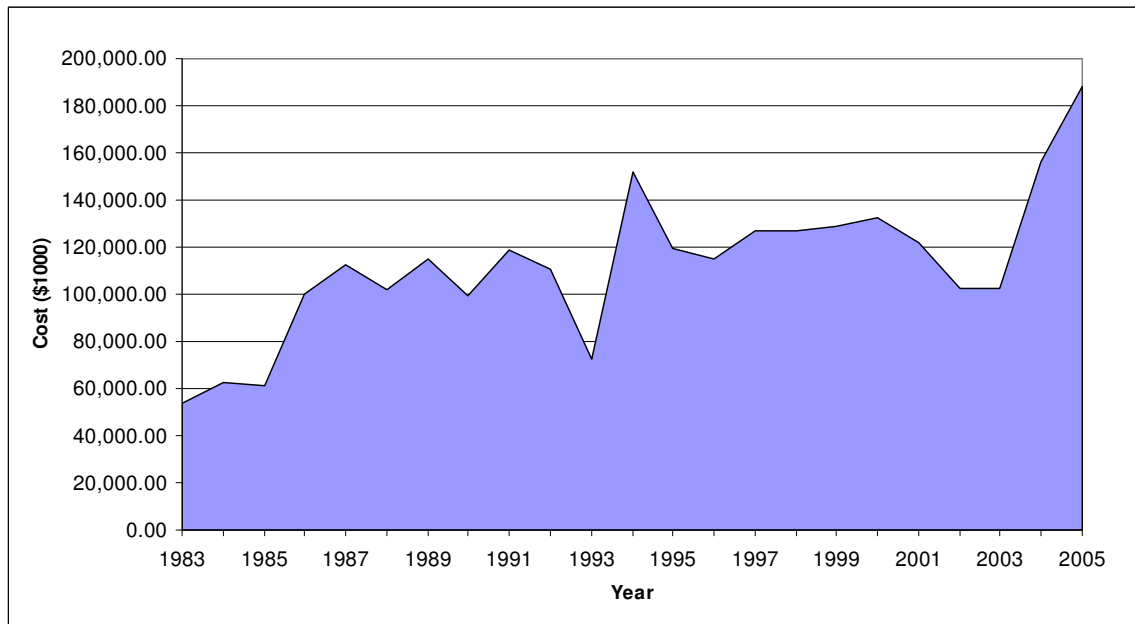
*source PacFIN

These shifts in market share likely represent permanent changes. If they do it means that the targeting of high value species is not a sustainable practice. We can't expect to maintain revenue from a species which isn't surviving commercial fishing.

There is a simple way in which we can measure up the cost of these shifts. For example, we can estimate a "with" and "without" comparison of the values of the fishery using prices from 2005. The "with" represents the landings and prices of the 2005 market with the catch ratio of 1982 and the "without" represents the status quo. The total ex vessel revenue in 2005 was \$72,589,000. Coincidentally, the opportunity to fish the 1982 Pacific Groundfish assemblage would generate approximately \$260,793,310 in revenue. Neither of these figures equate with sustainable catch levels, but it is clear that a significant opportunity cost exists with a shifting assemblage, \$188,204,210 in 2005 alone. In fact, each year that a shift in the assemblage occurs, it costs the industry. In figure 14, we display the year by year increase in value of having a 1982 assemblage. The annual increase in opportunity cost represents the negative impact of this externality on stakeholders.¹⁵

¹⁵ These costs are calculated using 2005 dollars.

Figure 14. Cost of Assemblage Shifts in the Pacific Groundfish Fishery



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