RESEARCH/PD ANNUAL REPORT - FINAL REPORT

2015 annual report - final
Trevor A. Branch
Social and economic effects of ITQs on the West Coast Groundfish fishery: solving the weak stock/bycatch problem
R/COCC/SS-1
Submitted On: 04/23/2016 12:01:19 PM

METRICS & MEASURES

Metric/Measure	Value	Note
Acres of coastal habitat	0	
Fishermen and seafood industry personnel	0	Funds were insufficient to poll all active fishing industry to see how many changed their behavior, so I marked "0".
Communities - economic and environmental development	0	Unknown.
Stakeholders - sustainable approaches	0	Unknown.
Informal education programs	0	
Stakeholders who receive information	100	Attend symposiums, talks, and workshops where presentations are made. Approximately 100 per year.
Volunteer hours	0	
P-12 students reached	0	4900 follow @TrevorABranch on Twitter, unknown how many are P-12 students
P-12 educators	0	4900 follow @TrevorABranch on Twitter, unknown how many are P-12 educators.

REQUESTED INFORMATION

Publications

Defining trade-offs among conservation, profitability, and food security in the California Cu bottom-trawl fishery
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2012
Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:
Publication URLs:
Abstract:
Citation: Hilborn, R., I. J. Stewart, T. A. Branch, and O. P. Jensen. 2012. Defining trade-offs amon conservation, profitability, and food security in the California Current bottom-trawl fishery. Conservat 26:257-266. doi: 10.1111/j.1523-1739.2011.01800.x
Citation for Coverpage:
SG can post PDF online?: Yes

Uploaded File: Hilborn_etal_2012_Defining_tradeoffs_among_conservation__California_Current.p

Linking Northeast Pacific recruitment synchrony to environmental variability
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2014
Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:
Publication URLs:
Abstract:
Citation: Stachura, M. M., T. E. Essington, N. J. Mantua, A. B. Hollowed, M. A. Haltuch, P. D. Sper Branch, and M. J. Doyle. 2014. Linking Northeast Pacific recruitment synchrony to environmental va Fisheries Oceanography 23:389-408
Citation for Coverpage:
SG can post PDF online?: No
Uploaded File:
Stachura_etal_2014_Linking_NE_Pacific_recruitment_synchrony_to_environmental_variability.pdf

A state-space approach for detecting growth variation and application to North Pacific grou
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2015
Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:
Publication URLs:
Abstract:
Citation: Stawitz, C. C., T. E. Essington, T. A. Branch, M. A. Haltuch, A. B. Hollowed, and P. D. Sp A state-space approach for detecting growth variation and application to North Pacific groundfish. Ca Journal of Fisheries and Aquatic Sciences 72:1316-1328.
Citation for Coverpage:
SG can post PDF online?: No
Uploaded File:
Stawitz_etal_2015_A_state_space_approach_for_detecting_growth_variation_NP_groundfish.pdf

Which design elements of individual quota fisheries help to achieve management objective
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2016
Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:
Publication URLs:
Abstract:
Citation: Melnychuk, M. C., T. E. Essington, T. A. Branch, S. S. Heppell, O. P. Jensen, J. S. Link, S Martell, A. M. Parma, J. G. Pope, and A. D. M. Smith. 2016. Which design elements of individual qu help to achieve management objectives? Fish and Fisheries 17:126-142
Citation for Coverpage:
SG can post PDF online?: No
Uploaded File:
Melnychuk_etal_2016_Which_design_elements_of_IQ_fisheries_achieve_management_objectives

Global fishery prospects under contrasting management regimes
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2016

Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:
Publication URLs:
Abstract:
Citation: Costello, C., D. Ovando, T. Clavelle, C. K. Strauss, R. Hilborn, M. C. Melnychuk, T. A. Bra Gaines, C. S. Szuwalski, R. B. Cabral, D. N. Rader, and A. Leland. 2016. Global fishery prospects u contrasting management regimes. Proceedings of the National Academy of Sciences U.S.A. doi: 10.1073/pnas.1520420113.
Citation for Coverpage:
SG can post PDF online?: No
Uploaded File: Costello_etal_2016_Global_fishery_prospects_under_contrasting_management_re

---

Catch shares have not led to catch-quota balancing in two North American multispecies tra
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: in review
Publication Authors:
Publisher Info:
Notes: In review.
Related URLs:
Keywords:
Publication URLs:
Abstract:
Citation: Kuriyama, P.K., Bellmann, M., Rutherford, K., Branch, T.A. (in review) Catch shares have catch-quota balancing in two North American multispecies trawl fisheries. Marine Policy.
Citation for Coverpage:
SG can post PDF online?: No
Uploaded File:

Effects of management tactics on meeting conservation objectives for western North Ameri groundfish fisheries
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2013
Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:
Publication URLs: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0056684
Abstract:
Citation: Melnychuk, M. C., J. A. Banobi, and R. Hilborn. 2013. Effects of management tactics on r conservation objectives for western North American groundfish fisheries. PLoS One 8 (2) DOI: 10.1371/journal.pone.0056684.
Citation for Coverpage:
SG can post PDF online?: Yes
Uploaded File:
Melnychuk_etal_2013_Effects_of_management_tactics_on_WN_American_groundfish_fisheries.p

---

The legal, regulatory, and institutional evolution of fishing cooperatives in Alaska and the W the United States
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2014
Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:

Publication URLs: http://www.sciencedirect.com/science/article/pii/S0308597X13001322
Abstract:
Citation: DeAlessi, M., J. M. Sullivan, and R. Hilborn. 2014. The legal, regulatory, and institutional e
fishing cooperatives in Alaska and the West Coast of the United States. Marine Policy 43: 217-225
Citation for Coverpage:
SG can post PDF online?: Yes
Uploaded File:
De_Alessi_etal_2014_Legal_regulatory_and_institutional_evolution_of_fishing_coops_Alaska_Wes

---

Accounting for marine reserves using spatial stock assessments
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2015
Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:
Publication URLs: http://www.nrcresearchpress.com/doi/pdf/10.1139/cjfas-2013-0364
Abstract:
Citation: McGilliard, C. R., Punt, A. E., Methot Jr, R. D., Hilborn, R., and Jacobson, L. 2014. Accou
marine reserves using spatial stock assessments. Can. J. Fish. Aquat. Sci. 72: 262-280.
Citation for Coverpage:
SG can post PDF online?: Yes
Uploaded File: McGilliard_etal_2015_Accounting_for_marine_reserves_using_spatial_stock_asse

---

**Real – time spatial management approaches to reduce bycatch and discards: experiences f
and the United States**
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2015
Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:
Publication URLs:
Abstract:
Citation: Little, A. S., C. L. Needle, R. Hilborn, D. S. Holland, and C. T. Marshall. 2015. Real – time
management approaches to reduce bycatch and discards: experiences from Europe and the United
and fisheries 16 (4), 576-602
Citation for Coverpage:
SG can post PDF online?: No
Uploaded File: Little_etal_2014_Real_time_spatial_management_approaches_to_reduce_bycatch

---

The effect of length bin width on growth estimation in integrated age-structured stock asse
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: Online, 2016
Publication Authors:
Publisher Info:
Notes: Corrected proof posted online, no volume or page numbers yet
Related URLs:
Keywords:
Publication URLs: http://www.sciencedirect.com/science/article/pii/S0165783615301259
Abstract:
Citation: Monnahan, C. C., K. Ono, S. C. Anderson, M. B. Rudd, A. C. Hicks, F. Hurtado-Ferro, K.
P. T. Kuriyama, R. R. Licandeo, C. C. Stawitz, I. G. Taylor, and J. L. Valero. 2015. The effect of leng
on growth estimation in integrated age-structured stock assessments. Fisheries Research doi:
10.1016/j.fishres.2015.11.002
Citation for Coverpage:
SG can post PDF online?: Yes

Uploaded File:
Monnahan_etal_2015_Effect_of_length_bin_width_on_growth_estimation_in_stock_assessments.p

An empirical weight-at-age approach reduces estimation bias compared to modeling param growth in integrated, statistical st
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2016 online
Publication Authors:
Publisher Info:
Notes: Corrected proofs online.
Related URLs:
Keywords:
Publication URLs: http://www.sciencedirect.com/science/article/pii/S0165783615300837
Abstract:
Citation: Kuriyama, P. T., K. Ono, F. Hurtado-Ferro, A. C. Hicks, I. G. Taylor, R. R. Licandeo, K. F. C. Anderson, C. C. Monnahan, M. B. Rudd, C. C. Stawitz, and J. L. Valero. 2015. An empirical weig approach reduces estimation bias compared to modeling parametric growth in integrated, statistical assessment models when growth is time varying. Fisheries Research doi: 10.1016/j.fishres.2015.09
Citation for Coverpage:
SG can post PDF online?: Yes
Uploaded File: Kuriyama_etal_2015_Empirical_weight_at_age_approach.pdf

Issues at the fore in the land of Magnuson and Stevens: a summary of the 14th Bevan Series Sustainable Fisheries
Publication Type: Peer-reviewed: Journals (incl. articles), Books, Proceedings, and Other Docume
Publication Year: 2015
Publication Authors:
Publisher Info:
Notes:
Related URLs:
Keywords:
Publication URLs: http://www.sciencedirect.com/science/article/pii/S0308597X14003492
Abstract:
Citation: Kuriyama, P. T., M. C. Siple, E. E. Hodgson, E. M. Phillips, M. Burden, D. Fluharty, A. E. Essington, J. Henderschedt, and D. A. Armstrong. 2015. Issues at the fore in the land of Magnuson Stevens: a summary of the 14th Bevan Series on Sustainable Fisheries. Marine Policy 54:118-121
Citation for Coverpage:
SG can post PDF online?: Yes
Uploaded File: Kuriyama_etal_2015_Issues_at_the_fore_in_the_land_of_Magnuson_and_Stevens

Students Supported

Peter Kuriyama (Continuing Student)
ptrkrym@uw.edu
University of Washington, School of Aquatic and Fishery Sciences

Field of Study: Aquatic and Fishery Sciences
Advisor: Trevor A. Branch
Degree Type: PhD
Degree Year: 2017

Student Project Title: The effects of weak stock constraints on catch, discards, and fishing behavi United States West Coast Groundfish Fishery

Involvement With Sea Grant This Period (capstone, fellow, intern, etc.): Graduate student, sta student supported by this project. Leveraged funding from Moore Foundation, and Sea Grant Popula Dynamics Fellowship allowed continuance to PhD.

Post-Graduation Plans (employer, grad school, etc.): NOAA.

Was this thesis/dissertation supported by Sea Grant?: Yes

Thesis / Dissertation: The effects of weak stock constraints on catch, discards, and fishing behavi United States West Coast Groundfish Fishery

New or Continuing?: continuing

Degree awarded this reporting period?: No

Financially supported?: Yes

Narratives

Narrative for final report: Social and economic effects of ITQs on the West Coast Groundfis solving the weak stock/byc
Uploaded File: Final_report.docx

Partners This Period

National Marine Fisheries Service
Types: Government
Scale: REGIONAL
Notes: Much of the original data we use in this project comes from NMFS, NOAA. In addition, we h postdoc to work on similar issues, leveraged by our funding on this project, through NOAA. Our clos here come from the Northwest Fisheries Science Center.

MRAG USA Ltd
Types: Other
Scale: FEDERAL or NATIONAL
Notes: A linked project looks at the effects of catch shares on the US west coast and in New Englar project is managed by MRAG USA Ltd, and the funding is from the Gordon and Betty Moore Founda is a consulting company specializing in fisheries issues.

University of California, Santa Barbara (UCSB)
Types: Academic Institution
Scale: REGIONAL
Notes: Funding for this project was through a collaboration with UCSB academic partners. The clos relationship resulted in a number of key follow-on papers, including this one: Costello C, Ovando D, Strauss CK, Hilborn R, Melnychuk MC, Branch TA, Gaines SD, Szuwalski CS, Cabral RB, Rader DI (2016) Global fishery prospects under contrasting management regimes. Proceedings of the Nationa of Sciences USA doi: 10.1073/pnas.1520420113

STANDARD QUESTIONS

Community Hazard Resilience

No **Community Hazard Resilience** information reported

Economic Impacts

No **Economic Impacts** information reported

Impacts and Accomplishments

(1)

Type	accomplishment
Title	Less bycatch, but lower catches; Washington Sea Grant research measures catch shares' effects on West Coast groundfish fisheries
Relevance	The West Coast groundfish fishery is valuable, complex and, for many species, recovering from overfishing. In 2011 the Pacific Fishery Management Council implemented individual fishing quotas (IFQs) or catch shares and groundfish revenues rose substantially. However, questions remained about the effects of IFQs on fish stocks and fishing communities, including ecological and social impacts and the approach's cost-effectiveness.
Response	Washington Sea Grant partnered with California Sea Grant to examine IFQ impacts on the groundfish fishery. The California researchers focused on social and economic consequences while the Washington team investigated effects on catch and bycatch levels and the condition of fish stocks.
Results	Findings were surprising. With the greater flexibility afforded by catch shares, researchers expected fleets to come closer to filling their allowed quotas. Instead, the overall catch-to-quota ratio declined significantly in the three years following implementation, from 41 to 29 percent. Meanwhile, nearby Canadian catch ratios declined much less, from 70 to 62 percent. This seems to reflect vigorous U.S. enforcement to protect depleted rockfish species, inhibiting fishing effort generally. Even a pool established by three California fishing communities to spread the risk of quota overages did not produce higher catches. In 2014, the U.S. Senate Commerce Committee invited testimony on the team's findings at a hearing to inform changes in federal fishery laws.
Recap	Sea Grant-funded researchers tracked the ecological and economic effects of catch shares on West Coast groundfish fisheries, revealing surprisingly low catches and laying the groundwork for changes in federal fishery management.
Comments	
Primary Focus Area	Healthy Coastal Ecosystems
Secondary Focus Areas	Sustainable Fisheries and Aquaculture,Resilient Communities and Economies
Goals	Ocean and coastal resources are managed using ecosystem-based approaches.|Coastal communities and economies are vibrant and resilient.
	Gordon and Betty More Foundation MRAG Americas

Partners	Northwest Fisheries Science Center (US DOC, NOAA, NMFS, NWFSC) University of California, Santa Barbara (UCSB)
PI Draft	* Type impact * Title Less waste, higher revenues: Washington and California Sea Grant researchers measure catch share effects on West Coast groundfish fisheries * Relevance The West Coast groundfish fishery is vast, valuable, complex, and has a number of overfished species. Revenues rose after the Pacific Fishery Management Council implemented individual fishing quotas (IFQs). But questions about effects on fish stocks and fishing communities can only be answered by objective, authoritative data on IFQ ecological and social impacts and return on investment. * Response Washington Sea Grant partnered with California Sea Grant to examine IFQ impacts on the groundfish fishery. Research focused primarily on fleet-wide catches, the status of fish stocks, and discard practices. Resources are being leveraged from the Moore Foundation and a Sea Grant- NMFS Fellowship to compare Northeast and West Coast IFQ experiences, assemble the best science about catch–share performance, and help guide future catch–share decisions. * Results Included above. * Recap Regional researchers are tracking ecological and economic effects of a new catch–share system on West Coast groundfish fisheries, including surprisingly low harvest levels, to provide insight into developing more effective quota systems. Comments Primary Focus Area Sustainable Fisheries and Aquaculture Secondary Focus Areas Resilient Communities and Economies Goals Fisheries are safe, responsibly managed and economically and culturally vibrant.,Coastal communities and economies are vibrant and resilient.,The public is ocean literate.,The future workforce is skilled in discilines critical to coastal and ocean economies and ecosystem health. Partners Fisheries and Oceans Canada (DFO) Gordon and Betty More Foundation MRAG Americas Northwest Fisheries Science Center (US DOC, NOAA, NMFS, NWFSC) University of California, Santa Barbara (UCSB)

Leveraged Funds

(1)

Purpose	Ecological effects of catch share programs in New England and U.S. West Coast groundfish fisheries.
Source	Gordon and Betty Moore Foundation subcontract through MRAG USA
Amount	69643
Start Date	02-01-2015

End Date	01-31-2016

(2)

Purpose	Evaluation of groundfish ecological response to current fisheries management systems
Source	National Oceanic and Atmospheric Administration (NOAA)
Amount	191000
Start Date	07-01-2014
End Date	06-30-2017

(3)

Purpose	Social and economic effects of ITQs on the West Coast Groundfish fishery: solving the weak stock/bycatch problem - conference travel
Source	ADMB Foundation
Amount	300
Start Date	02-08-2016
End Date	03-11-2016

(4)

Purpose	Social and economic effects of ITQs on the West Coast Groundfish fishery: solving the weak stock/bycatch problem - conference travel
Source	Alaska Sea Grant
Amount	500
Start Date	05-11-2015
End Date	05-15-2015

Meetings, Workshops, Presentations

(1)

Type of Event	Public or professional presentation
Description	Hartley, M*. and Branch, T.A*. A web-based toolkit of indicators for measuring the effects of catch share programs. Presentation to subcommittees of the Pacific Council, 11 June 2015, Spokane, WA.
Event Date	06-11-2015
Number of Attendees	60

(2)

Type of Event	Public or professional presentation
Description	Hilborn R. Invited Presidents Lecture, Shanghai ocean University "Status of fish stocks and how to sustain them"
Event Date	09-15-2015
Number of Attendees	150

(3)

Type of Event	Public or professional presentation
Description	Peter Kuriyama, Trevor Branch, Kate Rutherford, Marlene Bellman “Do catch shares improve catch-quota balancing” School of Aquatic and Fishery Sciences Graduate Student Symposium Seattle, WA
Event Date	11-19-2015
Number of Attendees	60

Tools, Technologies, Information Services / Sea Grant Products

No **Tools, Technologies, Information Services / Sea Grant Products** information reported

Narrative for final report: Social and economic effects of ITQs on the West Coast Groundfish fishery: solving the weak stock/bycatch problem

Lead PI: Trevor A. Branch

PI: Ray Hilborn

Graduate student supported: Peter Kuriyama

Amount: $305,279

Period Covered: 02/01/2012–01/31/2016

Background

Management of multispecies fisheries poses substantial problems over and above the usual issues faced by single-species fisheries. In single-species fisheries it is sufficient to gather data, conduct a fisheries assessment, estimate sustainable yield, and implement management measures that ensure catches are close to the sustainable yield. Multispecies fisheries are far more tricky: each species will differ in economic value, availability to fishing gear, and in their productivity. Since most fishing gears are not fully selective, it will generally not be possible to catch species in proportion to their productivity: slow-growing species will be "weak stocks" whose allowable catches will be reached first and then either be overfished or constrain the catches of fast-growing species (Squires et al. 1998, Branch & Hilborn 2008).

Individual fishing quotas (IFQs), more commonly now called catch-share fisheries (Costello et al. 2008), supply a possible solution to this issue. Under catch shares, each fishing entity is allocated a portion of the total allowable catch, and can choose when and where to catch this portion. They can also buy, sell, or lease these quota share portions to others in the fishery. When quota is exceeded for any species, fishing must be halted. Catch shares provide flexibility in how to fish and also in trading quota shares of different species to match what has been caught.

The U.S. west coast groundfish fishery moved to catch share management in January 2011 and provides a key example of the issues facing multispecies fisheries. A number of species are weak stocks, such as yelloweye rockfish and canary rockfish, for which annual fishery-wide quotas are very low. Indeed a single disaster tow of 47,000 pounds of canary rockfish has resulted in the F/V Seeker being banned from fishing in all of 2016 because it is not possible to obtain sufficient quota to cover such a large overage.

In this project we aimed to examine empirically how catch shares would alter fishing practices and the ability of fishers to more fully catch the total quotas for the many species in this fishery. We anticipated, based on experiences in the British Columbia groundfish fishery (hereafter BC fishery), that the additional flexibility would lead to higher utilization of fishing quota, leading to higher catch:quota ratios.

Objectives

Empirically examine the effects of catch shares on the U.S. west coast groundfish fisheries.

Methodology

We obtained time series data on discards, stock abundance, fishing mortality, catches, allowable catches, and fishing patterns. These data were examined to see how the fishery changed over time with the introduction of catch shares. As control groups, these data were compared with the BC fishery, which moved to catch shares in 1996. In a leveraged study with funding from the Moore Foundation, comparisons were also made with New England groundfish fishery, which also recently moved to a form of catch shares.

Rationale

Based on our past experience with catch share fisheries, and reviews of the literature on catch share fisheries (Branch 2009, Melnychuk et al. 2012, 2016), we anticipated major changes in the fishery, attributable to catch shares. Our partners at the University of California, Santa Barbara, focused on social and economic consequences, while we focused on ecological consequences.

Major findings

The main findings of the project are that fishers did not benefit from the increased flexibility offered by catch shares (Kuriyama et al. in review), which we expected would lead to higher catches relative to allowable quotas (catch:quota). Instead average catch:quota ratios declined significantly from 0.41 in the three years before catch shares to 0.29 in the three years afterwards (Table 1). In contrast, catch:quota ratios were much higher in the BC fishery over this period, and did not significantly change with catch shares (0.70 before vs. 0.62 after). The most likely explanation was that the risk of exceeding the allowable quotas for the weak species was perceived to be so high that fishers were cautious in when and where they fished. This resulted in low catch:quota ratios for both target species and weak species alike.

Table 1: comparison of catches and quotas (TAC) in the west coast fishery and the BC fishery.

Fishery Wide	**3 Years Before**	**3 Years After**
WC Average catch:TAC	0.41	0.29
BC Average catch:TAC	0.70	0.62
WC Summed Catches (mt)	78,584	57,492
WC Summed TAC (mt)	161,178	199,225
BC Summed Catches (mt)	93,662	78,746
BC Summed TAC (mt)	157,020	127,795

These low catch:quota ratios reflect the strong emphasis on the rebuilding plans for overfished species in this fishery. Indeed the low allowable quotas for these species have led to substantial rebuilding of all of the overfished stocks (Figure 1), although they still need to recover further to reach the target biomass at maximum sustainable yield (B_{MSY}). Despite this, the allowable catches for some species remain low. Famously, 46% of quota owners received less than 2.3 kg of yelloweye rockfish quota for the entire year (Figure 2), in a fishery where catches are measured in tens of thousands of tons.

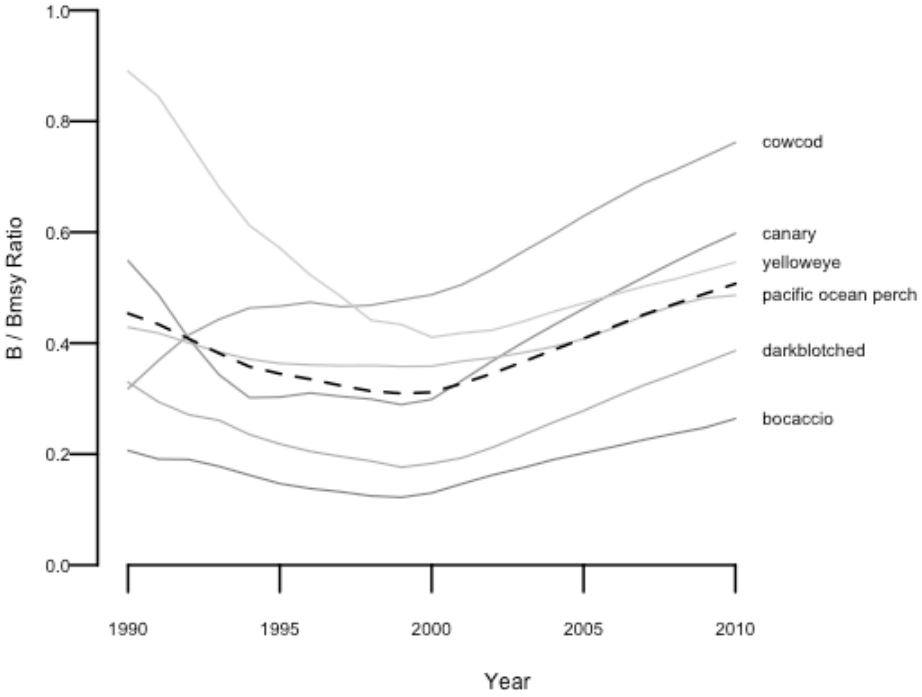


Figure 1: Trajectories of B / B_{MSY} for weak stock species in the West Coast fishery (Kuriyama in review).

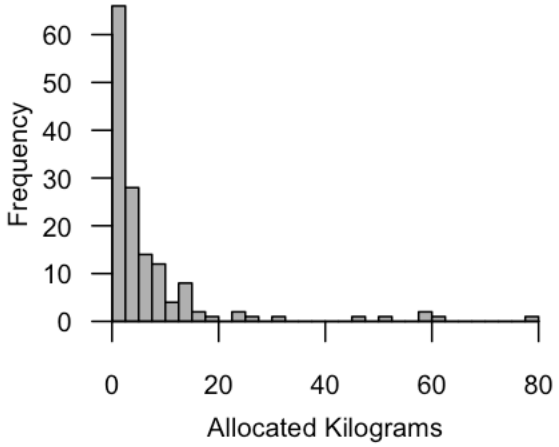


Figure 2: Individual quota allocations for yelloweye rockfish in the US west coast fishery (Kuriyama in review).

Our prediction was that if the weak stock species were constraining, then catch:quota ratios for those stocks should be close to one, but again to our surprise, catch:quota ratios for target species, weak stock species, and other species, were on average at low values after catch shares were introduced (Figure 3, 4), in contrast to the BC fishery where catches were much closer to quotas for targets and constraining species, but low for the other species. Only a few target species had catch:quota values close to one (Figure 4).

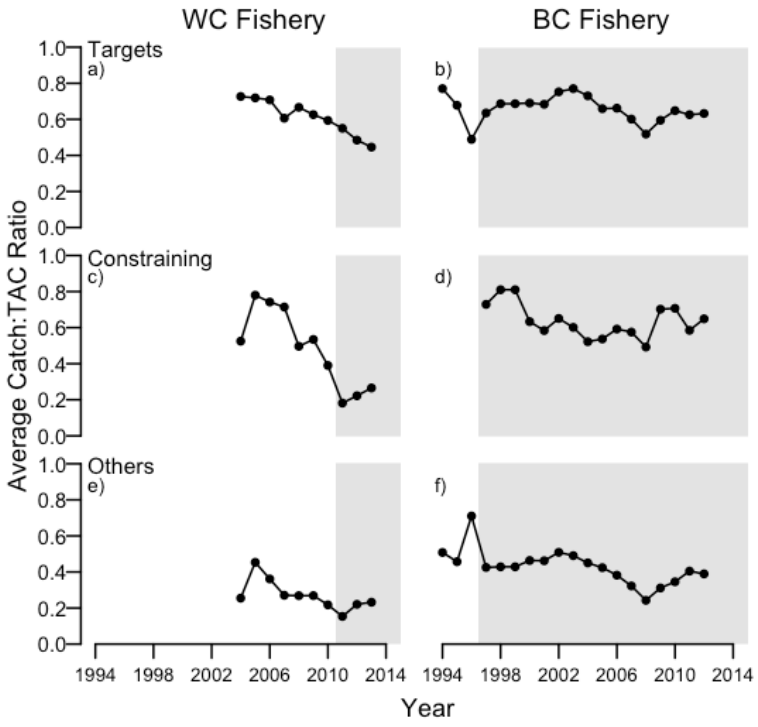


Figure 3: Plots of average catch:TAC ratios for target species (a), constraining species (b) , and other species (c). Years under catch share management (1997-2013 in BC and 2011-2013 in West Coast) are indicated by a light gray background color. Source: Kuriyama et al. (in review).

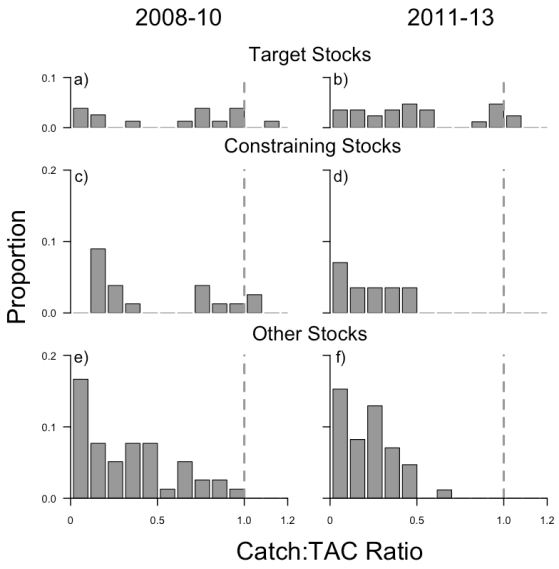


Figure 4: Histograms of catch:quota ratios for the US west coast fishery before (left) and after (right) catch shares were introduced. Only a few target stocks were close to allowable quotas after catch shares were introduced, yet fishery-wide catch-quota levels were low.

The two species with catches close to quotas, were petrale sole and sablefish (Figure 5). Sablefish is the most valuable species in the fishery, and changes in the fishery regulations gave fishers a greater ability to fish sablefish using other gear types. Once sablefish quota had been caught, it was not lucrative enough to go fishing for the other species, especially given the perceived high risk of exceeding quota share for the weak stock species.

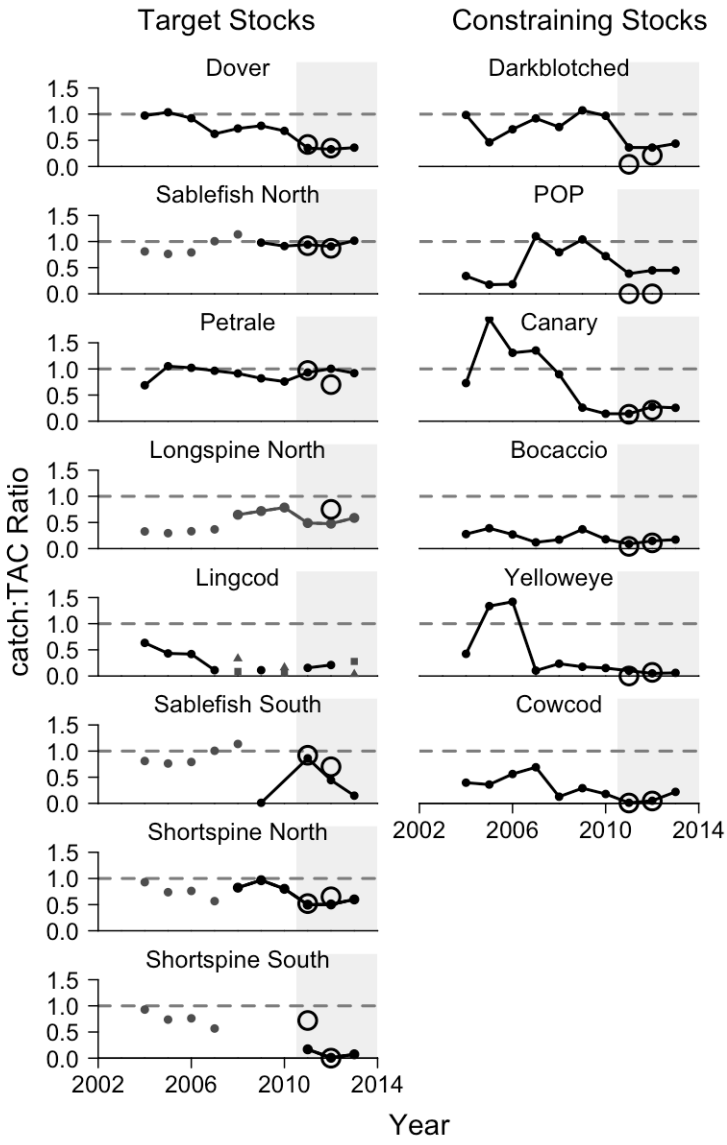


Figure 5: catch:quota ratios for individual species in the US west coast fishery, separated into target stocks (left column) and constraining stocks (right column). Open circles represent the ratios in the risk pool fishery in California.

One of the unique aspects of the US west coast fishery was the establishment of the Central California Risk Pool, with the help of coordination from The Nature Conservancy (TNC, a major quota holder in the

fishery). Fishers from three communities (Morro Bay, Fort Bragg and Half Moon Bay) collectively leased quota from TNC and developed spatial fishing plans that shared data to avoid catching constraining weak stock species. They also pooled their quota of bycatch species to reduce the risk of a disaster tow affecting any one fisher. Despite hopes that this risk pool would alleviate concerns about not being able to fully catch quotas, these fishers had catch:quota ratios that were not significantly different from those in the fishery as a whole (open circles in Figure 5). Thus it appears that risk pools had little observable impact on fishers being able to more fully catch the available quota.

In addition to these key findings in Kuriyama et al. (in review), funding also supported a wide array of additional research that is described briefly here. The funding supported graduate student Peter Kuriyama who has successfully bypassed from his initial MS into the Ph.D. program, and was awarded the NMFS/Sea Grant population dynamics fellowship for his future studies. He has published three scientific papers, two which provide advice for fisheries stock assessment, and one highlighting the impact of the Magnuson-Stevens fisheries act.

Another major publication (Hilborn et al. 2012) was a fishery-wide evaluation of the US west coast fishery, which found that total fishery-wide biomass remains high, and that fishing mortality is very low on average and was greatly reduced from 6% to 1% as part of the suite of management changes before catch shares were introduced (Figure 6). This paper highlighted the major trade-offs between catches and conservation objectives required to rebuild the overfished species.

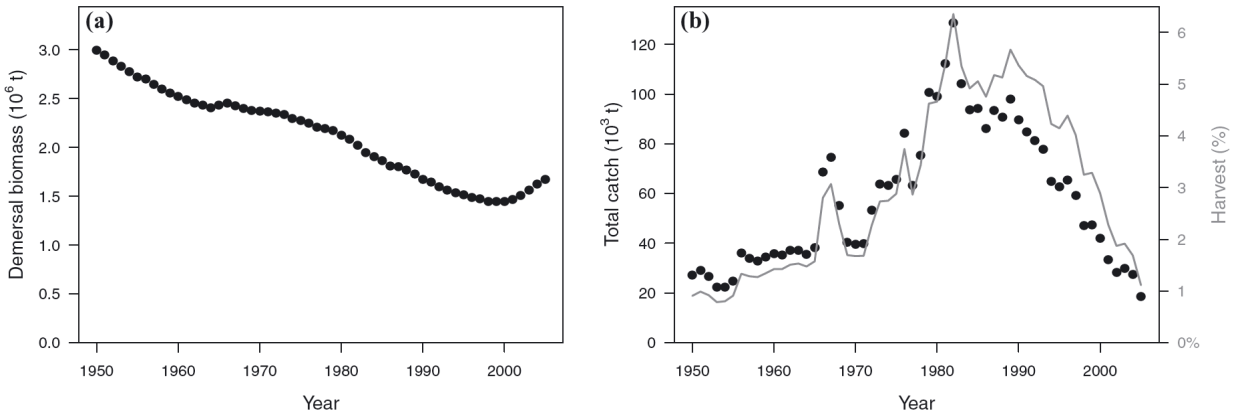


Figure 6: (a) Total demersal biomass and (b) catches (circles) and harvest rate (line) in the US west coast fishery. From: Hilborn et al. (2012).

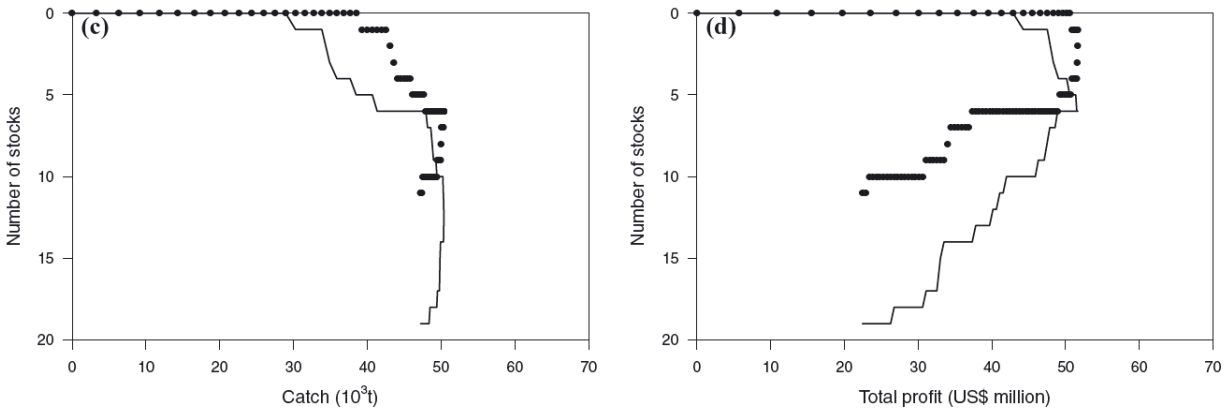


Figure 7: Relations between (c) sustainable yield and number of collapsed stocks (circles) and overfished stocks (line), and (d) total profit and number of collapsed stocks (circles) and overfished stocks (thin line). Source: Hilborn et al. (2012).

Some of the research conducted under this project was conducted jointly under another project (PI Branch, student Kuriyama), funded by the Moore Foundation, which is described under Information and Technology below. Those results included the impact of catch shares on US west coast discards, biomass, fishing mortality, catch:quota ratios, observer coverage, and shifts in spatial fishing effort (ongoing).

In addition to these projects, PI Branch and PI Hilborn coauthored a paper in PNAS with our UCSB partners on this proposal assessing the global status of fisheries and examining global fishery prospects under contrasting management regulations (Costello et al. 2016). One of the key results was the impact of catch share fisheries on future global fishery economic prospects. PI Branch also authored papers on groundfish recruitment synchrony (Stachura et al. 2014), on growth variation in North Pacific groundfish (Stawitz et al. 2015), and the impact of design elements in catch share fisheries on management objectives (Melnychuk et al. 2016). PI Hilborn also authored papers on the evolution of fishing cooperatives in Alaska and the west coast (De Alessi et al. 2014), accounting for marine reserves using spatial stock structure (McGilliard et al. 2015), real-time spatial approaches to reduce bycatch and discards (Little et al. 2015).

Significance of results

Our key finding was that if quotas are very low for some species in a multispecies fishery, even the flexibility offered by catch shares will be insufficient to allow fishers to fully catch the available quotas. Indeed, in this fishery the catch:quota ratio actually declined significantly after catch shares, since quotas are more restrictive than the previous management regime which allowed continued fishing (but no landings of weak stocks) after quotas for weak stock species were reached.

Outreach

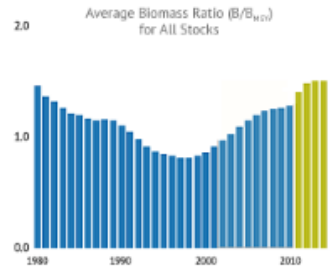
A major form of outreach was the website (www.catchshareindicators.org) described in the next section, where the results of this project are subsumed within a much larger project looking at social, economic and ecological indicators for the US west coast and New England fisheries.

Ray Hilborn developed a website http://cfooduw.org/ which hosts blogs about the status of fisheries, and allows fisheries scientists to comment in a timely manner on prominent fisheries issues. The blog has been visited by 18,000 people, and received 40,600 page views. An accompanying twitter account @cfoodUW has posted 1000 tweets, has >1000 followers, and these tweets were viewed 0.6 million times since the account was started 8 months ago.

Trevor Branch is moderately active on social media @TrevorABranch, explaining the research that he does to a general audience. Over the period of the funded research he posted 25,000 tweets, has almost 5,000 followers, and in the past 12 months, these tweets were viewed 4.8 million times.

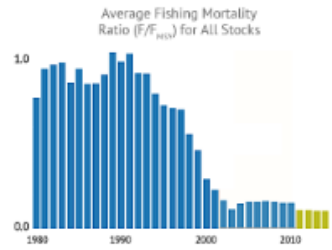
Information and technology transfer activities

Many of the results of this project are posted as they are calculated on the website www.catchshareindicators.org. As mentioned previously, PI Branch was awarded a grant from the Moore Foundation (lead PI Tim Essington) together with a larger group of economists and social scientists. Key results are presented there in interactive form, and include changes in discard rates and fishery status over time, in addition to changes in observer coverage. An overview is seen in Figure 8.

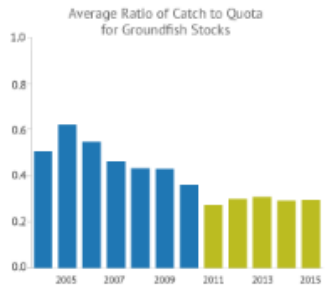


Has the status of fish stocks changed?

Biomass: On average, the groundfish stocks managed in the Shorebased IFQ Program have had a steady increase since the mid-1990s in the ratio of biomass (B) to the biomass that would produce maximum sustainable yields (B_{MSY}). Biomass ratios of groundfish stocks continued to increase following implementation of the Shorebased IFQ Program.

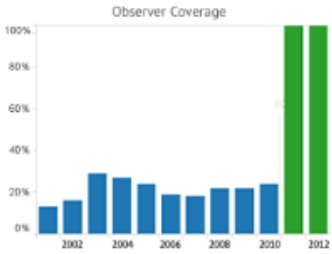


Fishing Mortality: On average, fishing mortality (F) remained above levels that would produce maximum sustainable yields (F_{MSY}) during the baseline period with the exception of 1991, and declined thereafter to levels near maximum sustainable yield. The average fishing mortality ratio remained at low and fairly steady levels during the project baseline period (2002–2010). In any given year, however, some individual stocks experienced high fishing mortality ($F>F_{MSY}$). Average fishing mortality ratio has decreased slightly since implementation of the Shorebased IFQ Program in 2011.



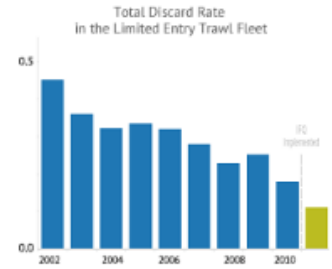
Have fleetwide catches stayed within quotas?

The average ratio of catch to quota (or catch utilization) across non-whiting groundfish stocks has been declining since 2004 and generally has remained low since implementation of the Shorebased IFQ Program. For all years since implementation of the Shorebased IFQ Program (2011-2015), catches for all stocks were lower than quota amounts.



Has quality of fishery data changed with changes in observer coverage?

The Pacific Fishery Management Council mandated that observers be present on 100 percent of trips under the catch share program, which represented a fivefold increase in observer coverage compared to the baseline period.



Have discarding practices changed?

For all methods of estimating discard ratios, the discard rate in the first year of the catch share program was lower than in any year in the previous decade.

Figure 8: Summary of the in-depth results from the overview page on www.catchshareindicators.org.

References

Branch TA (2009) How do individual transferable quotas affect marine ecosystems? Fish and Fisheries 10:39-57

Branch TA, Hilborn R (2008) Matching catches to quotas in a multispecies trawl fishery: targeting and avoidance behavior under individual transferable quotas. Canadian Journal of Fisheries and Aquatic Sciences 65:1435-1446

Costello C, Gaines SD, Lynham J (2008) Can catch shares prevent fisheries collapse? Science 321:1678-1681

Costello C, Ovando D, Clavelle T, Strauss CK, Hilborn R, Melnychuk MC, Branch TA, Gaines SD, Szuwalski CS, Cabral RB, Rader DN, Leland A (2016) Global fishery prospects under contrasting management regimes. Proceedings of the National Academy of Sciences USA doi: 10.1073/pnas.1520420113

De Alessi M, Sullivan JM, Hilborn R (2014) The legal, regulatory, and institutional evolution of fishing cooperatives in Alaska and the West Coast of the United States. Marine Policy 43:217-225

Hilborn R, Stewart IJ, Branch TA, Jensen OP (2012) Defining trade-offs among conservation, profitability, and food security in the California Current bottom-trawl fishery. Conservation Biology 26:257-266

Little AS, Needle CL, Hilborn R, Holland DS, Marshall CT (2015) Real-time spatial management approaches to reduce bycatch and discards: experiences from Europe and the United States. Fish and Fisheries 16:576-602

McGilliard CR, Punt AE, Methot Jr RD, Hilborn R, Jacobson L (2015) Accounting for marine reserves using spatial stock assessments. Canadian Journal of Fisheries and Aquatic Sciences 72:262-280

Melnychuk MC, Essington TE, Branch TA, Heppell SS, Jensen OP, Link JS, Martell SJD, Parma AM, Pope JG, Smith ADM (2012) Can catch share fisheries better track management targets? Fish and Fisheries 13:267-290

Melnychuk MC, Essington TE, Branch TA, Heppell SS, Jensen OP, Link JS, Martell SJD, Parma AM, Pope JG, Smith ADM (2016) Which design elements of individual quota fisheries help to achieve management objectives? Fish and Fisheries 17:126-142

Squires D, Campbell H, Cunningham S, Dewees C, Grafton RQ, Herrick SFJ, Kirkley J, Pascoe S, Salvanes K, Shallard B, Turris B, Vestergaard N (1998) Individual transferable quotas in multispecies fisheries. Marine Policy 22:135-159

Stachura MM, Essington TE, Mantua NJ, Hollowed AB, Haltuch MA, Spencer PD, Branch TA, Doyle MJ (2014) Linking Northeast Pacific recruitment synchrony to environmental variability. Fisheries Oceanography 23:389-408

Stawitz CC, Essington TE, Branch TA, Haltuch MA, Hollowed AB, Spencer PD (2015) A state-space approach for detecting growth variation and application to North Pacific groundfish. Canadian Journal of Fisheries and Aquatic Sciences 72:1316-1328