Supporting Information

Melnychuk et al.: *Which design elements of individual quota fisheries help to achieve management objectives?*

Semideviation as a third metric of response variables

In addition to interannual means and standard deviations, 5-year semideviations of *ln*(catch**:**TAC), *ln*(F**:**F_{target}), and *ln*(B**:**B_{target}) were also calculated for each stock. Semideviation is a measure of asymmetric risk around a target value, combining the frequency and magnitude of exceeding some target into an undesirable state (Porter, 1974, Sethi et al., 2012, Melnychuk et al., 2013). It represents the variability only on the undesirable side of the management target (i.e. catches exceeding TACs, exploitation rates exceeding target exploitation rate, and biomass below target biomass). Semideviation is zero if values are at or more conservative than management targets throughout the 5-year period, and increases as values become increasingly undesirable with respect to target values.

Results for semideviations were consistent with observed results for mean responses of the ratios. Mean responses near management targets corresponded with small semideviations, and larger semideviations were observed when mean responses were further from targets. Semideviations were also influenced to some extent by interannual variability, but in general corresponded more closely with mean responses. Results for semideviations in both the mixed effects-model analysis (Tables S2–S4) and random forests analysis (Figs. S1–S3) are presented below, along with the detailed results for means and standard deviations.

Random forests and regional patterns

In the main text, partial dependence plots showed the overall relationships between response variables and numerical predictor variables (Fig. 1). Below, we separate these overall relationships into relationships for separate regions: New Zealand, Australia, east coast of

Canada, west coast of Canada, as well as an 'other' category pooling individual quota (IQ) fisheries from the U.S., Europe, South Africa, and South America (Figs. S1–S3). In these partial dependence plots, we draw the reader's attention towards the range of predictor variable values with reliable sample sizes. We superimpose grey bands over the upper and lower extremes of predictor variable values to emphasize that only 10% of the values of predictor variables fall within these extremes (Figs. S1–S3), so observed patterns within these extremes are likely sensitive to sparse data.

Linear mixed-effects models

In the main text, Fig. 4 summarized the relative support for 18 candidate models which were compared using information-theoretic methods. These candidate models represented a variety of hypotheses about which IQ attributes or regional factors best explained the variation in the six response variables, and the nature of the effect (i.e. whether interactions among predictor variables were supported). The measure of relative support for candidate models is a standardized model weight for each analysis (model weights sum to 1 across the 18 models), which is based on Akaike Information Criterion corrected for small sample size, AICc. These AICc values for each model (along with model likelihoods and the number of estimated parameters) are presented in Tables S2–S4.

Supporting information references

Melnychuk, M.C., Banobi, J.A., Hilborn, R. (2013) Effects of management tactics on meeting conservation objectives for western North American groundfish fisheries. *PLoS ONE* **8,** e56684.

Porter, R.B. (1974) Semivariance and stochastic dominance: A comparison. *American Economic Review* **64,** 200-204.

Sethi, S.A., Dalton, M., Hilborn, R. (2012) Quantitative risk measures applied to Alaskan commercial fisheries. *Canadian Journal of Fisheries and Aquatic Sciences* **69,** 487-498.

Supporting information tables

Table S1. Stocks managed under IQs included in analyses. Headings are abbreviated as R (region) and H (taxonomic/habitat association). '✓' indicates the stock is included in analyses for catch to quota (catch**:**TAC). '*A*' indicates that values of F and F_{target}, and/or of B and B_{target}, were drawn from assessments. '*S*' indicates that reference points F_{target} and/or B_{target} were not available from stock assessments and were instead estimated using a Schaefer surplus production model. Values of the means, standard deviations, and semideviations of these variables are listed in the supplementary file, 'Melnychuk et al - catch F B response variable data.xls'. Superscripts and footnotes denote changes to default habitat associations and aggregations of catch:TAC data.

R	H	Species name	Common name	Sub-region	C**:**TAC	F**:**F_{target}	B**:**B_{target}
U.S. – West coast/Alaska							
	Bathydemersal fish						
		Anoplopoma fimbria	Sablefish	Bering Sea/Aleutian Is./G. Alaska	✓	*A*	*A*
	Demersal fish						
		Hippoglossus stenolepis	Pacific halibut	G. Alaska/W. coast Canada & U.S.	✓	*A*	*A*
	Benthopelagic fish						
		Theragra chalcogramma	Walleye pollock	Bering Sea	✓	*A*	*A*
		Merluccius productus [1]	Pacific hake	W. coast U.S.	✓	*A*	*A*
West coast Canada							
	Bathydemersal fish						
		Anoplopoma fimbria	Sablefish	Coastwide	✓	*A*	*A*
		Sebastes aleutianus	Rougheye rockfish	Coastwide	✓		
		Sebastes alutus	Pacific ocean perch	Coastwide	✓	*A*	*A*
		Sebastes borealis	Shortraker rockfish	Coastwide	✓		
		Sebastes proriger	Redstripe rockfish	Coastwide	✓		
		Sebastes reedi	Yellowmouth rockfish	Coastwide	✓	*A*	*A*
		Sebastolobus alascanus	Shortspine thornyhead	Coastwide	✓		
		Sebastolobus altivelis	Longspine thornyhead	Coastwide	✓		
	Demersal fish						
		Eopsetta jordani	Petrale sole	Coastwide	✓	*S*	*S*
		Gadus macrocephalus	Pacific cod	Hecate Strait	✓	*S*	*S*
		Gadus macrocephalus	Pacific cod	W. coast of Vancouver Is.	✓		
		Lepidopsetta bilineata	Rock sole	Hecate Strait	✓		

R	H	Species name	Common name	Sub-region	C:TAC	F:F_{target}	B:B_{target}
		Lepidopsetta bilineata	Rock sole	W. coast of Vancouver Is.	✓		
		Microstomus pacificus	Dover sole	Coastwide	✓		
		Ophiodon elongatus	Lingcod	3C	✓[2]	*A*	*A*
		Ophiodon elongatus	Lingcod	3D	✓[2]	*A*	*A*
		Ophiodon elongatus	Lingcod	5AB	✓[2]	*A*	*A*
		Ophiodon elongatus	Lingcod	5CDE	✓[2]	*A*	*A*
		Parophrys vetulus	English sole	Hecate Strait	✓	*S*	*S*
		Parophrys vetulus	English sole	W. coast of Vancouver Is.	✓		
		Sebastes brevispinis	Silvergray rockfish	Coastwide	✓		
	Benthopelagic fish						
		Sebastes flavidus	Yellowtail rockfish	Coastwide	✓		
		Sebastes pinniger	Canary rockfish	Coastwide	✓	*A*	*A*
		Squalus acanthias	Spiny dogfish	Coastwide	✓		
		Theragra chalcogramma	Walleye pollock	Coastwide	✓		
	Pelagic fish						
		Clupea pallasii	Pacific herring	Central Coast	✓	*A*	*A*
		Clupea pallasii	Pacific herring	Prince Rupert District	✓	*A*	*A*
		Clupea pallasii	Pacific herring	Queen Charlotte Is.			*A*
		Clupea pallasii	Pacific herring	Strait of Georgia	✓	*A*	*A*
		Clupea pallasii	Pacific herring	W. coast of Vancouver Is.			*A*
		Sebastes entomelas	Widow rockfish	Coastwide	✓		
	Invertebrates						
		Panopea abrupta	Geoduck	Coastwide	✓		
		Parastichopus californicus	California sea cucumber	Coastwide	✓		
		Strongylocentrotus droebachiensis	Green sea urchin	Coastwide	✓		
		Strongylocentrotus franciscanus	Red sea urchin	Coastwide	✓		
East coast Canada							
	Demersal fish						
		Glyptocephalus cynoglossus	Witch flounder	NAFO 3Ps	✓	*S*	*S*
		Hippoglossoides platessoides	American plaice	NAFO 4T	✓		
		Hippoglossus hippoglossus	Atlantic halibut	NAFO 3NOPs4VWX5Zc	✓		
		Limanda ferruginea	Yellowtail flounder	NAFO 3LNO	✓	*A*	*A*
		Melanogrammus aeglefinus	Haddock	NAFO 4X5Y	✓		
		Melanogrammus aeglefinus	Haddock	NAFO 5Zejm	✓		
		Urophycis tenuis	White hake	NAFO 4VW			*S*
	Benthopelagic fish						
		Gadus morhua	Atlantic cod	NAFO 3Ps	✓	*S*	*S*
		Gadus morhua	Atlantic cod	NAFO 4TVn			*S*

R	H	Species name	Common name	Sub-region	C:TAC	F:F_{target}	B:B_{target}
		Gadus morhua	Atlantic cod	NAFO 4X	✓		
		Gadus morhua	Atlantic cod	NAFO 5Zjm	✓		
		Reinhardtius hippoglossoides	Greenland halibut	NAFO 01ABCDEF	✓		
	Pelagic fish						
		Clupea harengus [1]	Atlantic herring	NAFO 4R	✓ [3]		
		Clupea harengus [1]	Atlantic herring	Scotian Shelf and Bay of Fundy	✓		
		Mallotus villosus	Capelin	NAFO 4RST	✓		
		Pollachius virens [1]	Pollock	NAFO 4VWX5Zc	✓	*S*	*S*
		Sebastes mentella & S. fasciatus	Redfish	NAFO 3O	✓		
	Invertebrates						
		Chionoecetes opilio	Snow crab	NAFO 2J3KLNOPs4R	✓		
		Chionoecetes opilio	Snow crab	Areas 20-24 (Scotian Shelf)	✓		
		Chionoecetes opilio	Snow crab	S. G. St. Lawrence	✓		
		Pandalus borealis	Northern shrimp	NAFO 4S	✓		
		Pandalus borealis	Northern shrimp	NAFO 2G-3K	✓		
		Pandalus borealis	Northern shrimp	SFA 13,14,15 (E. Scotian Shelf)	✓		
		Placopecten magellanicus	Sea scallop	SPA 1-6 (Bay of Fundy)	✓		
		Placopecten magellanicus	Sea scallop	SFA 10-12,25-27 (Georges Bank)	✓	*S*	*S*
		Mactromeris polynyma	Arctic surfclam	NAFO 4Vsc	✓		
		Strongylocentrotus droebachiensis	Green sea urchin	LFA 38	✓		
U.S. - Northeast & Mid-Atlantic coast							
	Invertebrates						
		Arctica islandica	Ocean quahog	Coastwide	✓		
		Placopecten magellanicus	Sea scallop	Georges Bank		*S*	*S*
		Placopecten magellanicus	Sea scallop	Mid-Atlantic coast		*S*	*S*
		Spisula solidissima	Atlantic surfclam	Mid-Atlantic coast	✓	*A*	*A*
Europe							
	Demersal fish						
		Melanogrammus aeglefinus	Haddock	Iceland	✓	*S*	*S*
		Solea vulgaris	Common European sole	North Sea	✓		
	Benthopelagic fish						
		Gadus morhua	Atlantic cod	Iceland	✓	*S*	*S*
		Micromesistius poutassou	Blue whiting	Northeast Atlantic		*S*	*S*
	Pelagic fish						
		Clupea harengus [1]	Atlantic herring	Iceland (summer spawners)	✓	*A*	*S*
		Mallotus villosus	Capelin	Iceland	✓	*S*	*S*
South Africa							
	Bathydemersal fish						

R	H	Species name	Common name	Sub-region	C:TAC	F:F_{target}	B:B_{target}
		Merluccius capensis	Shallow-water cape hake	Coastwide		*S*	*A*
		Merluccius paradoxus	Deep-water cape hake	Coastwide	✓		*A*
	Pelagic fish						
		Engraulis encrasicolus	Anchovy	Coastwide	✓	*S*	*S*
		Sardinops sagax	Sardine	Coastwide	✓	*S*	*A*
	Invertebrates						
		Haliotis midae	South African abalone	Coastwide	✓		
		Palinurus gilchristi	Southern spiny lobster	S. coast	✓	*S*	*S*
South America							
	Benthopelagic fish						
		Merluccius hubbsi	Argentine hake	N. coast		*A*	*A*
		Merluccius hubbsi	Argentine hake	S. coast		*A*	*A*
Australia							
	Bathydemersal fish						
		Genypterus blacodes	Ling	SE Shelf (E.)	✓	*S*	*A*
		Genypterus blacodes	Ling	SE Shelf (W.)			*A*
	Demersal fish						
		Nemadactylus macropterus	Jackass morwong	SE Shelf	✓	*S*	*A*
		Neoplatycephalus richardsoni	Tiger flathead	SE Shelf	✓		*A*
		Sillago flindersi	School whiting	SE Shelf	✓	*S*	*A*
	Benthopelagic fish						
		Centroberyx affinis	Redfish	SE Shelf	✓		
		Hoplostethus atlanticus	Orange roughy	SE Shelf (E.)	✓	*S*	*A*
		Hoplostethus atlanticus	Orange roughy	SE Shelf (W.)	✓		
		Hyperoglyphe antarctica	Blue eye trevalla	SE Shelf	✓		
		Macruronus novaezelandiae	Blue grenadier	SE Shelf	✓	*S*	*A*
		Pseudocaranx dentex	Silver trevally	SE Shelf	✓		
		Rexea solandri	Common gemfish	SE Shelf			*A*
		Sebastes melanops	Blue warehou	SE Shelf (W.)			*A*
		Seriolella brama	Blue warehou	SE Shelf (E.)			*A*
		Seriolella punctata	Silverfish *(silver warehou)*	SE Shelf	✓	*S*	*A*
		Zenopsis nebulosus	Mirror dory	SE Shelf	✓		
		Zeus faber	John dory	SE Shelf	✓		
	Pelagic fish						
		Sardinops sagax	Pilchard *(sardine)*	S. Australia	✓		
	Invertebrates						
		Haliotis laevigata	Green-lipped abalone	Tasmania	✓		
		Haliotis rubra	Black-lipped abalone	Tasmania	✓		

R	H	Species name	Common name	Sub-region	C:TAC	F:F_{target}	B:B_{target}
		Haliporoides sibogae	Royal red prawn	SE Shelf	✓		
		Jasus edwardsii	Rock lobster	Tasmania	✓	*S*	*S*
		Pseudocarcinus gigas	Tasmanian giant crab	Tasmania	✓		
New Zealand							
	Bathydemersal fish						
		Genypterus blacodes	Ling	LIN 6b		*A*	*A*
		Genypterus blacodes	Ling	LIN 72	✓ [4]	*A*	*A*
		Genypterus blacodes	Ling	LIN 7WC-WCSI	✓ [4]	*A*	*A*
		Genypterus blacodes	Ling	LIN 3,4	✓	*A*	*A*
		Genypterus blacodes	Ling	LIN 5,6	✓	*A*	*A*
		Pseudocyttus maculatus	Smooth oreo	Chatham Rise	✓ [5]	*A*	*A*
		Pseudocyttus maculatus	Smooth oreo	West end of Chatham Rise	[6]	*A*	*A*
		Pseudocyttus maculatus	Smooth oreo	Bounty Plateau		*A*	*A*
		Pseudocyttus maculatus	Smooth oreo	East Pukaki Rise		*A*	*A*
		Pseudocyttus maculatus	Smooth oreo	Southland		*A*	*A*
	Demersal fish						
		Callorhinchus milii	Elephantfish	Countrywide	✓		
		Chelidonichthys kumu	Red gurnard	Countrywide	✓		
		Kathetostoma giganteum	Stargazer	Countrywide	✓	*A*	*A*
		Latridopsis ciliaris	Blue moki	Countrywide	✓		
		Mustelus lenticulatus	Rig	Countrywide	✓		
		Nemadactylus macropterus	Tarakihi	Countrywide	✓	*A*	*A*
		Parapercis colias	Blue cod	Countrywide	✓		
		Plagiogeneion rubiginosum	Rubyfish	Countrywide	✓		
		Polyprion oxygeneios, P. americanus	Groper	Countrywide	✓		
		Pseudophycis bachus	Red cod	Countrywide	✓		
		Seriolella caerulea	White warehou	Countrywide	✓		
	Benthopelagic fish						
		Allocyttus niger	Black oreo	West end of Chatham Rise	✓ [6]	*A*	*A*
		Allocyttus niger	Black oreo	Pukaki Rise		*A*	*A*
		Allocyttus niger	Black oreo	OEO1,6	✓ [7]		
		Beryx splendens, B. decadactylus	Alfonsino	Countrywide	✓		
		Chrysophrys auratus	New Zealand snapper	SNA 8	✓	*A*	*A*
		Chrysophrys auratus	New Zealand snapper	SNA 1	✓		
		Galeorhinus galeus	School shark	Countrywide	✓		
		Hoplostethus atlanticus	Orange roughy	Mid-east coast	✓	*A*	*A*
		Hoplostethus atlanticus	Orange roughy	ORH3B	✓	*A*	*A*
		Hyperoglyphe antarctica	Bluenose	Countrywide	✓		

R	H	Species name	Common name	Sub-region	C:TAC	F:F_{target}	B:B_{target}
		Macruronus novaezelandiae	Hoki	E. New Zealand	✓ [8]	*A*	*A*
		Macruronus novaezelandiae	Hoki	W. New Zealand	✓ [8]	*A*	*A*
		Merluccius australis	Southern hake	Chatham Rise	✓	*A*	*A*
		Merluccius australis	Southern hake	Sub-Antarctic	✓	*A*	*A*
		Micromesistius australis	Southern blue whiting	Aukland,Bounty,Pukaki	✓		
		Micromesistius australis	Southern blue whiting	Campbell Is. Rise	✓	*A*	*A*
		Mugil cephalus	Grey mullet	Countrywide	✓		
		Pseudocaranx dentex	Trevally	TRE 7	✓	*A*	*A*
		Rexea solandri	Common gemfish	Countrywide	✓	*A*	*A*
		Sebastes melanops	Blue warehou	Countrywide	✓		
		Seriolella punctata	Silver warehou	Countrywide	✓		
		Thyrsites atun	Barracouta	Countrywide	✓		
		Trachurus declivis, T. novaezelandiae, T. murphyi	Jack mackerels	Countrywide	✓		
	Invertebrates						
		Haliotis iris	New Zealand abalone *(paua)*	PAU 2	✓		
		Haliotis iris	New Zealand abalone *(paua)*	PAU 3	✓		
		Haliotis iris	New Zealand abalone *(paua)*	PAU 4	✓		
		Haliotis iris	New Zealand abalone *(paua)*	PAU 5A north	✓ [9]	*A*	*A*
		Haliotis iris	New Zealand abalone *(paua)*	PAU 5A south	✓ [9]	*A*	*A*
		Haliotis iris	New Zealand abalone *(paua)*	PAU 5B	✓	*S*	*S*
		Haliotis iris	New Zealand abalone *(paua)*	PAU 5D	✓	*S*	*S*
		Haliotis iris	New Zealand abalone *(paua)*	PAU 7	✓	*A*	*A*
		Jasus edwardsii	Red rock lobster	CRA 1	✓		
		Jasus edwardsii	Red rock lobster	CRA 2	✓		
		Jasus edwardsii	Red rock lobster	CRA 3	✓		
		Jasus edwardsii	Red rock lobster	CRA 4	✓	*S*	*S*
		Jasus edwardsii	Red rock lobster	CRA 5	✓		
		Jasus edwardsii	Red rock lobster	CRA 6	✓		
		Jasus edwardsii	Red rock lobster	CRA 7	✓	*S*	*S*
		Jasus edwardsii	Red rock lobster	CRA 8	✓	*S*	*S*
		Nototodarus gouldi, N. sloanii	Arrow squid	Countrywide	✓		
Total					142	76	86

[1] Some habitat classifications were changed from those listed in FishBase to more accurately represent the species. Changes included: Pacific hake (*Merluccius productus*) to benthopelagic; Atlantic herring (*Clupea harengus*) to pelagic; and pollock (or saithe, *Pollachius virens*) to pelagic.

[2] Catch and quota for B.C. lingcod from subareas 3C, 3D, 5AB, and 5CDE are pooled.

[3] Catch and quota for Canada 4R Atlantic herring are pooled over spring and fall spawners.

[4] Catch and quota for New Zealand ling LIN 72 and LIN 7WC-WCSI are pooled.

[5] Catch and quota for New Zealand Chatham Rise smooth oreo (*Pseudocyttus maculatus*) and black oreo (*Allocyttus niger*) are pooled.

[6] Catch and quota for New Zealand West end of Chatham Rise black oreo (*Allocyttus niger*) and smooth oreo (*Pseudocyttus maculatus*) are pooled.

[7] Catch and quota for New Zealand OEO 1,6 black oreo (*Allocyttus niger*) and smooth oreo (*Pseudocyttus maculatus*) are pooled.

[8] Catch and quota for New Zealand hoki are pooled for eastern and western sub-stocks.

[9] Catch and quota for New Zealand paua are pooled for sub-areas 5An and 5As.

Table S2. Model selection results for linear mixed-effects model analyses of catch to quota ratios: (a) mean *ln*(catch**:**TAC); (b) standard deviation of *ln*(catch**:**TAC); (c) semideviation of *ln*(catch**:**TAC). Header abbreviations are: *k*, number of parameters; $-2 \cdot ln(L)$, two times the negative log-likelihood (i.e. deviance) calculated using maximum likelihood; AICc, Akaike Information Criterion scores corrected for small sample sizes; and ΔAICc, difference in AICc with that of the lowest value across models.

Model [1]	*k*	$-2 \cdot ln(L)$	AICc	ΔAICc
(a) Mean *ln*(catch:TAC)				
1 (null model)	6	66.6	79.3	9.0
2 (security/durability)	7	66.6	81.5	11.2
3 (transferability)	7	66.5	81.3	11.1
4 (overages/underages transfer)	7	65.3	80.2	9.9
5 (exclusivity)	7	65.8	80.7	10.5
6 (industry involvement)	7	66.6	81.4	11.2
7 (years since implementation)	7	62.2	77.0	6.8
8 (region)	13	57.8	86.7	16.5
9 (all main effects without region)	12	57.0	83.4	13.2
10 (all main effects with region)	19	43.2	87.5	17.2
11 (industry involvement × security)	9	66.5	85.8	15.6
12 (industry involvement × transferability)	9	61.6	81.0	10.8
13 (industry involvement × over/underages)	9	62.9	82.3	12.1
14 (industry involvement × exclusivity)	9	50.9	70.2	0.0
15 (years in IQ × security)	9	61.2	80.5	10.3
16 (years in IQ × transferability)	9	62.0	81.4	11.2
17 (years in IQ × over/underages)	9	60.3	79.7	9.5
18 (years in IQ × exclusivity)	9	55.7	75.1	4.9
(b) SD of *ln*(catch:TAC)				
1 (null model)	6	-86.6	-74.0	6.8
2 (security/durability)	7	-87.0	-72.2	8.6
3 (transferability)	7	-88.8	-74.0	6.8
4 (overages/underages transfer)	7	-88.2	-73.3	7.4
5 (exclusivity)	7	-88.1	-73.2	7.5
6 (industry involvement)	7	-88.7	-73.9	6.9
7 (years since implementation)	7	-89.6	-74.7	6.1
8 (region)	13	-93.7	-64.9	15.9
9 (all main effects without region)	12	-97.1	-70.7	10.1

Model [1]	*k*	$-2 \cdot ln(L)$	AICc	ΔAICc
10 (all main effects with region)	19	-108.5	-64.2	16.6
11 (industry involvement × security)	9	-90.3	-71.0	9.8
12 (industry involvement × transferability)	9	-98.1	-78.7	2.1
13 (industry involvement × over/underages)	9	-90.3	-70.9	9.9
14 (industry involvement × exclusivity)	9	-100.2	-80.8	0.0
15 (years in IQ × security)	9	-90.1	-70.8	10.0
16 (years in IQ × transferability)	9	-92.1	-72.7	8.1
17 (years in IQ × over/underages)	9	-91.8	-72.4	8.4
18 (years in IQ × exclusivity)	9	-91.1	-71.8	9.0
(c) Semideviation of *ln*(catch:TAC)				
1 (null model)	6	-336.0	-323.4	0.2
2 (security/durability)	7	-337.6	-322.8	0.8
3 (transferability)	7	-336.4	-321.5	2.1
4 (overages/underages transfer)	7	-338.4	-323.6	0.0
5 (exclusivity)	7	-336.5	-321.6	1.9
6 (industry involvement)	7	-336.2	-321.4	2.2
7 (years since implementation)	7	-336.3	-321.4	2.1
8 (region)	13	-344.0	-315.1	8.4
9 (all main effects without region)	12	-344.2	-317.8	5.8
10 (all main effects with region)	19	-349.7	-305.4	18.2
11 (industry involvement × security)	9	-338.0	-318.6	5.0
12 (industry involvement × transferability)	9	-336.8	-317.4	6.1
13 (industry involvement × over/underages)	9	-338.5	-319.1	4.5
14 (industry involvement × exclusivity)	9	-337.2	-317.8	5.8
15 (years in IQ × security)	9	-338.3	-319.0	4.6
16 (years in IQ × transferability)	9	-337.7	-318.3	5.3
17 (years in IQ × over/underages)	9	-339.3	-320.0	3.6
18 (years in IQ × exclusivity)	9	-338.0	-318.6	5.0

[1] See Figure 4 of main text for terms contained in each model. Base terms in all models include average catch, year of fishery development and age at 1st maturity as fixed effects as well as taxonomic/habitat association as a random effect. Models 1–10 involve only main effects and models 11–18 also involve interactions.

Table S3. Model selection results for linear mixed-effects model analyses of exploitation rate to target exploitation rate: (a) mean $ln(F{:}F_{target})$; (b) standard deviation of $ln(F{:}F_{target})$; (c) semideviation of $ln(F{:}F_{target})$. Header abbreviations are: k, number of parameters; $-2 \cdot ln(L)$, two times the negative log-likelihood (i.e. deviance) calculated using maximum likelihood; AICc, Akaike Information Criterion scores corrected for small sample sizes; and ΔAICc, difference in AICc with that of the lowest value across models.

Model [1]	k	$-2 \cdot ln(L)$	AICc	ΔAICc
(a) Mean $ln(F{:}F_{target})$				
1 (null model)	6	180.2	193.4	6.2
2 (security/durability)	7	180.1	195.8	8.5
3 (transferability)	7	179.6	195.3	8.1
4 (overages/underages transfer)	7	180.1	195.7	8.5
5 (exclusivity)	7	179.8	195.4	8.2
6 (industry involvement)	7	176.5	192.1	4.9
7 (years since implementation)	7	180.1	195.8	8.6
8 (region)	14	162.5	197.4	10.2
9 (all main effects without region)	12	174.4	203.3	16.1
10 (all main effects with region)	20	158.3	213.6	26.4
11 (industry involvement × security)	9	176.4	197.1	9.9
12 (industry involvement × transferability)	9	175.3	196.0	8.8
13 (industry involvement × over/underages)	9	175.2	195.9	8.7
14 (industry involvement × exclusivity)	9	166.5	187.2	0.0
15 (years in IQ × security)	9	179.0	199.7	12.5
16 (years in IQ × transferability)	9	177.9	198.6	11.4
17 (years in IQ × over/underages)	9	179.1	199.8	12.6
18 (years in IQ × exclusivity)	9	179.6	200.4	13.2
(b) SD of $ln(F{:}F_{target})$				
1 (null model)	6	-95.8	-82.6	1.4
2 (security/durability)	7	-97.6	-81.9	2.1
3 (transferability)	7	-99.7	-84.0	0.0
4 (overages/underages transfer)	7	-97.4	-81.7	2.3
5 (exclusivity)	7	-96.7	-81.1	2.9
6 (industry involvement)	7	-95.9	-80.2	3.8
7 (years since implementation)	7	-96.4	-80.8	3.3
8 (region)	14	-98.1	-63.2	20.8
9 (all main effects without region)	12	-100.5	-71.5	12.5

Model [1]	*k*	–2·*ln*(*L*)	AICc	ΔAICc
10 (all main effects with region)	20	-108.0	-52.7	31.3
11 (industry involvement × security)	9	-98.0	-77.3	6.7
12 (industry involvement × transferability)	9	-100.0	-79.3	4.7
13 (industry involvement × over/underages)	9	-97.9	-77.1	6.9
14 (industry involvement × exclusivity)	9	-98.6	-77.9	6.2
15 (years in IQ × security)	9	-99.2	-78.5	5.5
16 (years in IQ × transferability)	9	-99.7	-79.0	5.0
17 (years in IQ × over/underages)	9	-98.4	-77.6	6.4
18 (years in IQ × exclusivity)	9	-97.1	-76.4	7.6
(c) Semideviation of *ln*(F:F_{target})				
1 (null model)	6	27.5	40.7	5.8
2 (security/durability)	7	27.4	43.1	8.1
3 (transferability)	7	27.5	43.1	8.2
4 (overages/underages transfer)	7	27.0	42.6	7.7
5 (exclusivity)	7	27.5	43.1	8.2
6 (industry involvement)	7	20.2	35.8	0.9
7 (years since implementation)	7	27.3	42.9	7.9
8 (region)	14	7.9	42.8	7.8
9 (all main effects without region)	12	17.8	46.8	11.8
10 (all main effects with region)	20	6.3	61.6	26.6
11 (industry involvement × security)	9	18.3	39.0	4.0
12 (industry involvement × transferability)	9	20.1	40.9	5.9
13 (industry involvement × over/underages)	9	20.2	40.9	5.9
14 (industry involvement × exclusivity)	9	14.2	35.0	0.0
15 (years in IQ × security)	9	24.4	45.1	10.2
16 (years in IQ × transferability)	9	25.8	46.5	11.6
17 (years in IQ × over/underages)	9	26.3	47.1	12.1
18 (years in IQ × exclusivity)	9	26.6	47.4	12.4

[1] See Figure 4 of main text for terms contained in each model. Base terms in all models include average catch, year of fishery development and age at 1st maturity as fixed effects as well as taxonomic/habitat association as a random effect. Models 1–10 involve only main effects and models 11–18 also involve interactions.

Table S4. Model selection results for linear mixed-effects model analyses of biomass to target biomass: (a) mean $ln(B{:}B_{target})$; (b) standard deviation of $ln(B{:}B_{target})$; (c) semideviation of $ln(B{:}B_{target})$. Header abbreviations are: *k*, number of parameters; $-2 \cdot ln(L)$, two times the negative log-likelihood (i.e. deviance) calculated using maximum likelihood; AICc, Akaike Information Criterion scores corrected for small sample sizes; and ΔAICc, difference in AICc with that of the lowest value across models.

Model [1]	*k*	$-2 \cdot ln(L)$	AICc	ΔAICc
(a) Mean $ln(B{:}B_{target})$				
1 (null model)	6	201.6	214.7	22.6
2 (security/durability)	7	200.7	216.1	24.0
3 (transferability)	7	197.5	213.0	20.9
4 (overages/underages transfer)	7	198.8	214.2	22.1
5 (exclusivity)	7	201.5	216.9	24.8
6 (industry involvement)	7	201.4	216.9	24.8
7 (years since implementation)	7	200.9	216.3	24.2
8 (region)	14	158.2	192.1	0.0
9 (all main effects without region)	12	187.1	215.4	23.3
10 (all main effects with region)	20	141.9	194.8	2.7
11 (industry involvement × security)	9	197.3	217.7	25.6
12 (industry involvement × transferability)	9	194.8	215.2	23.1
13 (industry involvement × over/underages)	9	197.7	218.1	26.0
14 (industry involvement × exclusivity)	9	193.4	213.8	21.7
15 (years in IQ × security)	9	196.2	216.5	24.4
16 (years in IQ × transferability)	9	178.9	199.2	7.1
17 (years in IQ × over/underages)	9	195.7	216.1	24.0
18 (years in IQ × exclusivity)	9	200.2	220.5	28.4
(b) SD of $ln(B{:}B_{target})$				
1 (null model)	6	-119.9	-106.9	0.0
2 (security/durability)	7	-122.0	-106.6	0.3
3 (transferability)	7	-119.9	-104.5	2.4
4 (overages/underages transfer)	7	-120.0	-104.5	2.3
5 (exclusivity)	7	-120.6	-105.2	1.7
6 (industry involvement)	7	-120.0	-104.5	2.3
7 (years since implementation)	7	-120.1	-104.7	2.2
8 (region)	14	-125.6	-91.7	15.2
9 (all main effects without region)	12	-124.6	-96.4	10.5

Model [1]	*k*	–2·*ln*(*L*)	AICc	ΔAICc
10 (all main effects with region)	20	-142.3	-89.4	17.5
11 (industry involvement × security)	9	-122.2	-101.8	5.1
12 (industry involvement × transferability)	9	-120.6	-100.2	6.7
13 (industry involvement × over/underages)	9	-120.9	-100.6	6.3
14 (industry involvement × exclusivity)	9	-120.9	-100.6	6.3
15 (years in IQ × security)	9	-122.9	-102.5	4.4
16 (years in IQ × transferability)	9	-121.5	-101.1	5.8
17 (years in IQ × over/underages)	9	-120.1	-99.7	7.1
18 (years in IQ × exclusivity)	9	-121.7	-101.4	5.5
(c) Semideviation of *ln*(B:B$_{target}$)				
1 (null model)	6	115.2	128.2	20.1
2 (security/durability)	7	113.8	129.3	21.2
3 (transferability)	7	115.1	130.5	22.4
4 (overages/underages transfer)	7	105.9	121.4	13.2
5 (exclusivity)	7	115.2	130.6	22.5
6 (industry involvement)	7	114.8	130.2	22.1
7 (years since implementation)	7	115.0	130.5	22.3
8 (region)	14	74.2	108.1	0.0
9 (all main effects without region)	12	101.6	129.8	21.7
10 (all main effects with region)	20	62.4	115.3	7.2
11 (industry involvement × security)	9	108.1	128.5	20.4
12 (industry involvement × transferability)	9	114.5	134.8	26.7
13 (industry involvement × over/underages)	9	105.3	125.7	17.6
14 (industry involvement × exclusivity)	9	108.1	128.4	20.3
15 (years in IQ × security)	9	109.9	130.3	22.2
16 (years in IQ × transferability)	9	106.5	126.9	18.8
17 (years in IQ × over/underages)	9	103.6	124.0	15.8
18 (years in IQ × exclusivity)	9	114.6	135.0	26.9

[1] See Figure 4 of main text for terms contained in each model. Base terms in all models include average catch, year of fishery development and age at 1st maturity as fixed effects as well as taxonomic/habitat association as a random effect. Models 1–10 involve only main effects and models 11–18 also involve interactions.

Supporting information figures

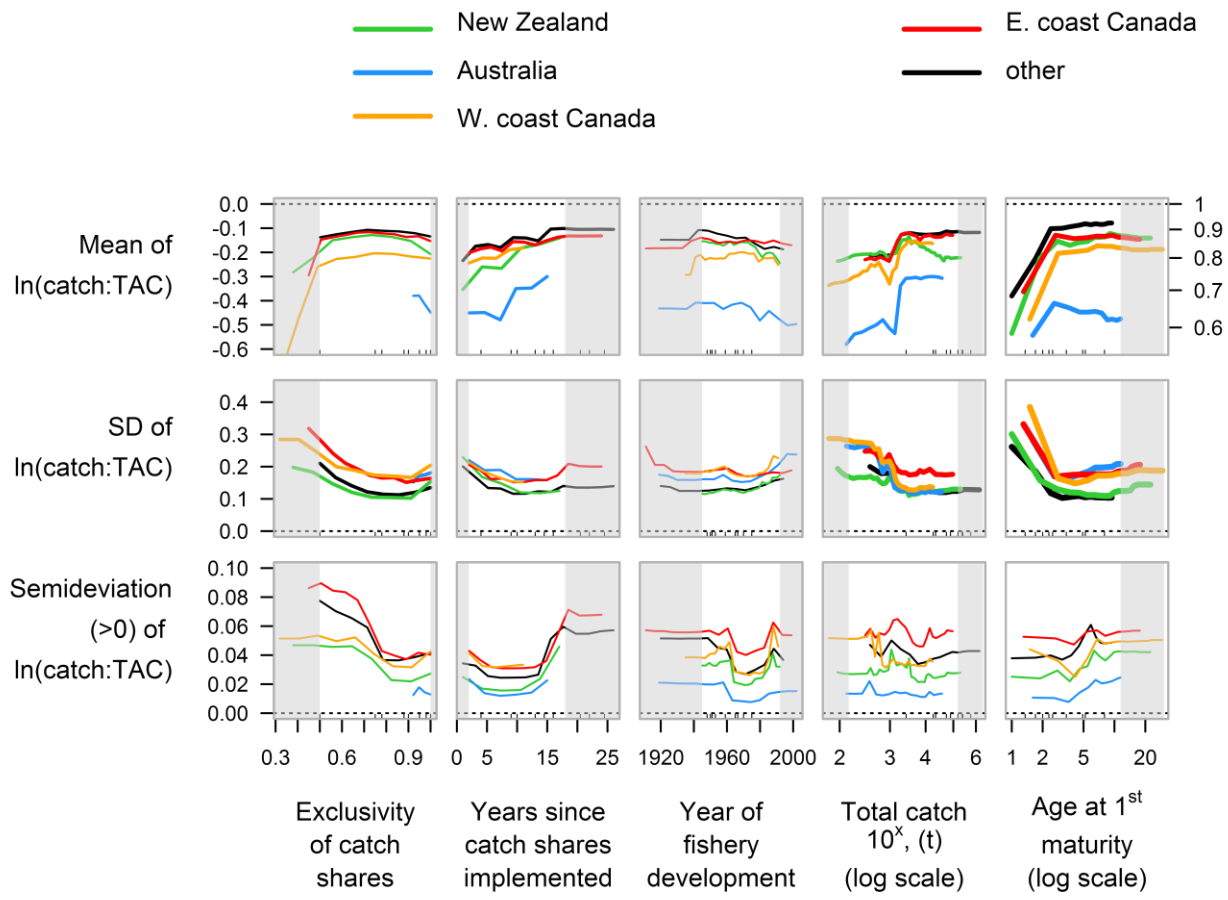

Figure S1. Partial dependence of three catch to quota metrics on five numerical stock-level predictors of IQ fisheries. The mean, standard deviation, and semideviation of the log-ratio of catch**:**TAC were calculated for each stock for the 2000–2004 period. The three variables were analyzed independently using random forests (10,000 trees, 5 predictors randomly sampled at each split). Color-coded lines show marginal effects of a predictor across stocks within a region ('other' includes U.S., Europe, South Africa, and South America). Line thickness is proportional to the relative importance score of the predictor for that response variable. Horizontal dotted lines at 0 represent general management objectives. Tick marks in each plot show deciles of predictor values; the region between grey-shaded areas contain 90% of the predictor values while grey-shaded areas contain the upper and lower 5% of predictor values. Right-hand axis shows mean catch**:**TAC values on linear scale. The assumed model included all nine main effects as described in the text as well as a 5-level 'region' predictor.

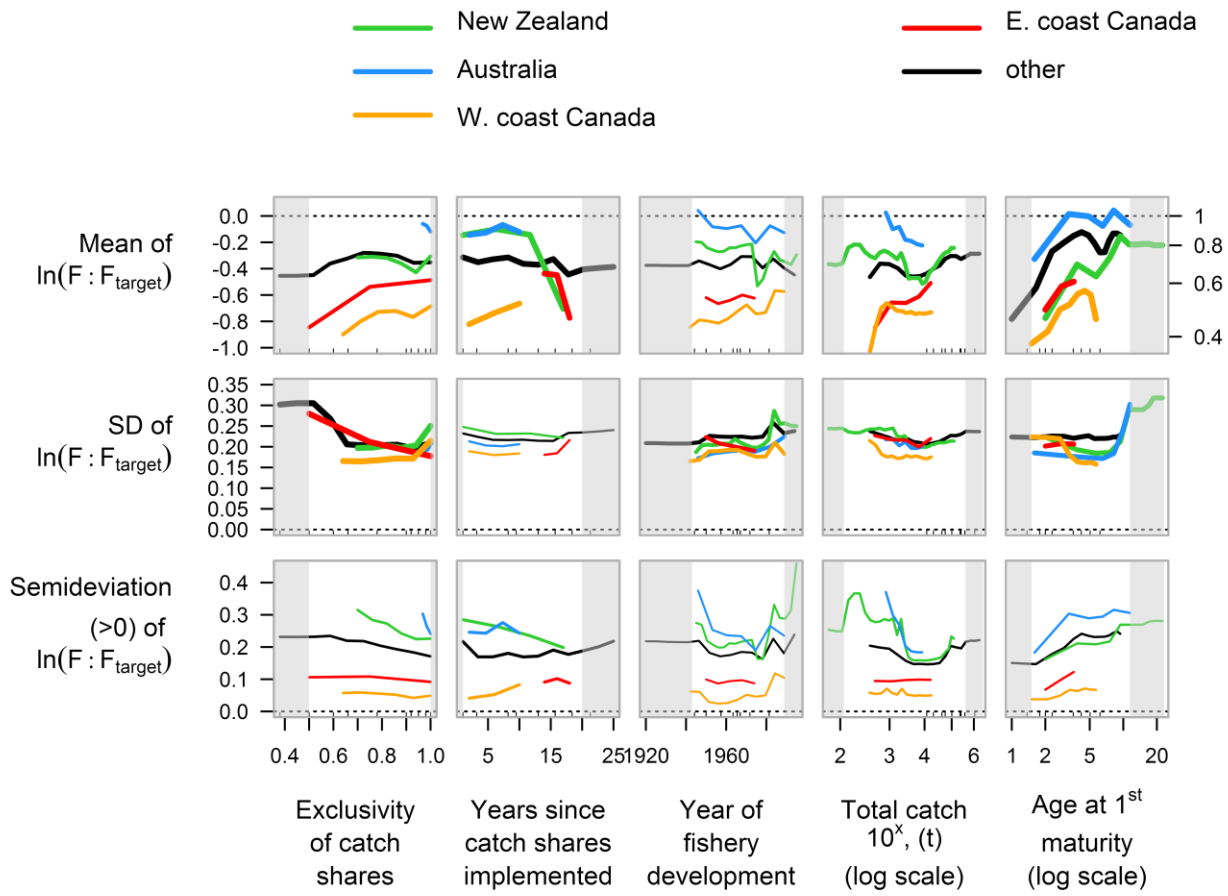

Figure S2. Partial dependence of three exploitation rate metrics on five numerical stock-level predictors of IQ fisheries. The mean, standard deviation, and semideviation of the log-ratio of current exploitation rate to target exploitation rate were calculated for each stock for the 2000–2004 period. See Fig. S1 caption for further details.

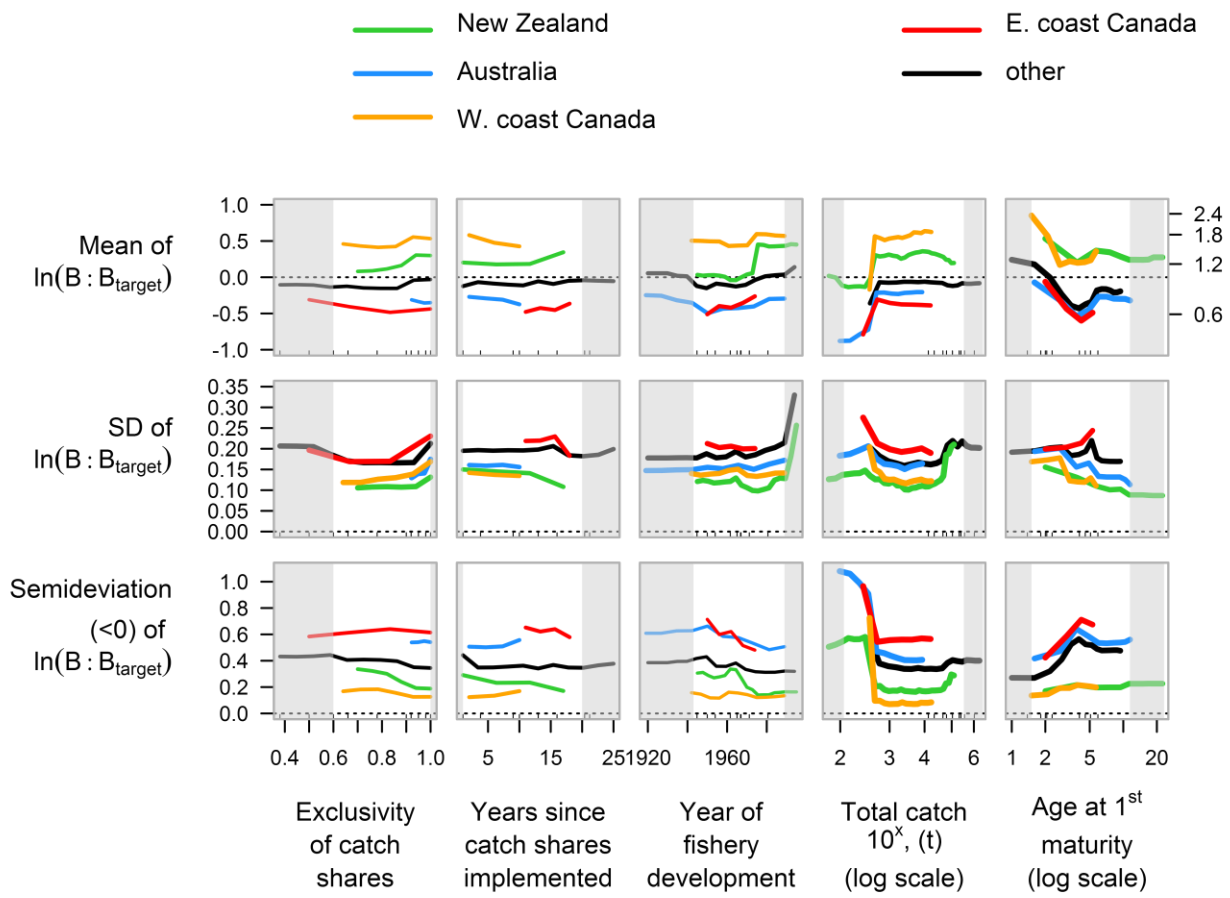

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Figure S3. Partial dependence of three biomass metrics on five numerical stock-level predictors of IQ fisheries. The mean, standard deviation, and semideviation of the log-ratio of current
140 biomass to target biomass were calculated for each stock for the 2000–2004 period. See Fig. S1 caption for further details.