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Consolidation and control in the New Zealand quota managed inshore fishery.

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Abstract

The introduction of individual transferable quotas to the New Zealand fishery has seen the gradual concentration of both quota ownership and catch – especially in the deepwater fishery. This paper examines the levels of concentration of quota ownership, catch and fish receiving (by fish processors) for the top 18 species in New Zealand's inshore fishery. It uses concentration ratios, the Herfindahl-Hirschman Index and the Lorenz curve to measure and compare the levels of consolidation. The study combines 'associated entities' (companies with common directors) when measuring concentration. Using internationally recognized benchmarks for concentration, the New Zealand inshore fishery is assessed to be unconcentrated in quota ownership and catch but relatively more concentrated in fish receiving. It is evident that quota-owning licenced fish receivers typically rely on self-employed fishers to fish their quota. This enables fishers without quota to continue operating, and also allows fish receivers to benefit from the expertise of career fishers.

Keywords: Quota management system, consolidation, control, catch shares, fishers.
Q22, Q28.

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Introduction

The condition of the world's marine fisheries has become an area of increasing concern over the last forty years or more. Governments have experimented with a variety of regulatory tools to limit both overfishing and adverse ecological effects of fishing. One approach to reducing overfishing that has attracted extensive research and policy attention is the adoption of Individual Transferrable Quotas – or ITQs (Chu, 2009; Arnason, 2002; Costello et al., 2008; Grafton, 1996a, Young et al., 2018). ITQs are used in a variety of countries including: Iceland (Arnason, 2005; Byrne et al., 2020; Chambers and Carothers, 2017; Eythórsson, 2000; Gunnlaugsson et al., 2020), Norway (Hannesson, 2013 and 2017; Standal and Asche, 2018), the United States (Holland et al., 2017; Hsueh and Kasperski, 2018; Brewer et al., 2017; Carothers and Chambers, 2017), Canada (Edwards and Pinkerton, 2020; Hoshino et al., 2020), Chile (Kroetz et al., 2017), Australia (Pascoe et al., 2020; Kawamoto and Baba, 2020; Innes et al., 2014), and New Zealand (Hersoug, 2018; Kerr, 2004; Stewart et al., 2006; Yandle and Dewees, 2008).

Upon adoption of an ITQs regime, the government allocates a specified proportion of the Total Allowable Catch (TAC) of a fishery to fishers or fishing companies (usually based on catch history). The allocated ITQ can then be sold or otherwise transferred between market participants. This transferability provides a mechanism for fishers to choose to exit a fishery (Byrne et al., 2020; Grafton, 1996b; Stewart et al., 2006), allowing a more orderly reduction of effort in the fishery. This characteristic and the incentives it creates (as well as the criteria for making the initial allocation) are central to the extensive debate over the positive and negative effects of ITQs (See, for example, Arnason, 2012; Carothers and Chambers, 2012; Chu, 2009; Copes, 1986; Costello et

al., 2008; McCay, 1995 and 2004; Pinkerton and Edwards, 2009, Sumaila, 2010; Young et al., 2018.)

One key area of concern is consolidation: the concentration of a high percentage of catching rights in the hands of only a few fishery participants. Consolidation raises concerns over market power, and social welfare (Abayomi and Yandle, 2012; Helgesen, 2022). Market power refers to concerns that conditions may encourage a non-competitive market to develop for product, quota, or labour (Byrne et al., 2020; McEvoy et al., 2009; Grainger and Parker, 2013). Social welfare concerns are most commonly raised about consolidation. These focus on the shift of wealth and fishery control from local (particularly indigenous) communities (Bodwitch, 2017; Carothers, 2015; Mccormack, 2016).

Because of these concerns, most ITQ regimes (including New Zealand) place upper limits on the consolidation of quota (Byrne et al., 2020; Dewees, 1998; Sanchirico et al., 2006). As we discuss below, New Zealand is a particularly dynamic case for understanding consolidation issues under ITQs.

New Zealand Quota Management System (QMS)

New Zealand has a significant presence in the fisheries management literature. New Zealand's Quota Management System (QMS) covers the commercial fishing of 98 species or species groups (spread over 642 fish stocks) inside the country's Economic Exclusion Zone (EEZ). The New Zealand EEZ is roughly 1.2 million square nautical miles, the fourth largest in the world. The

industry is responsible for NZ$ 2 billion in exports, consisting of 267,901 tonne of seafood exports in 2018 (Seafood, 2021)

The New Zealand fishery is divided into two distinct sectors. The deepwater sector targets species including orange roughy, squid, hake, and hoki. It is dominated by a small number of large vertically integrated harvesting and processing companies. The inshore sector targets a variety of species including snapper, flounder, rock lobster, and gurnard. Harvesters in the inshore fisheries consist mostly of independent small-scale fishers who sell their catch to the vertically integrated companies; and by boats that are owned by the vertically integrated companies with hired crews (Yandle and Dewees, 2008; Stewart and Moriarity, 2017). New Zealand became one of the first countries to introduce ITQ management in 1986, a time when the offshore sector was rapidly expanding, and the inshore sector was facing retrenchment (Yandle and Dewees, 2008). The inshore sector is the focus of this study.

Much of the literature on New Zealand's QMS focuses on 1) describing the approach taken (Clark et al., 1988; Annala, 1996); 2) the assessment of its economic and scientific performance (Batstone and Sharp, 1999; Bisack et al., 2006; Mace et al., 2014) and 3) a debate over the social consequences of the QMS (Boyd and Dewees, 1992; Yandle and Dewees, 2003; Stewart et al., 2006; Stewart and Callagher, 2011; Simmons and Stringer, 2014). Closely related are discussions of the impact that the QMS has had on New Zealand's indigenous Māori communities. This impact was recognized relatively early (Memon and Cullen, 1992) and led to explicit incorporation of Māori rights into both the commercial ITQ system and the creation of customary

catching rights (Inns, 2013; Yandle, 2007). This process, and the challenges faced by Māori in fisheries management are well described and analyzed in Bodwitch 2017.

One highly studied issue in New Zealand fisheries management (and one of the topics of this analysis) is limitations placed on the consolidation of ITQs. With aggregation limits varying from 10% for spiny rock lobster to 35% for certain offshore species (Fisheries Act, 1996), New Zealand's consolidation limits are among the least restrictive. This makes New Zealand an excellent case for understanding how consolidation happens in an ITQ management system. Early attention on consolidation began appearing in the 1990s (Bevin et al., 1990; Dewees, 1998). The first statistical analysis (Connor, 2000) showed that consolidation was indeed occurring, but not at the rate anticipated. Further analyses documented the effects of consolidation on small-scale fishers (Stewart and Walshe, 2008; Stewart et al., 2006) and argued that consolidation was the logical consequence of a functioning ITQ market (Newell et al., 2005). Consolidation of ITQ ownership clearly occurs, but its intensity varies between location of fishery, whether it is export-oriented, and by point in time, (Yandle and Dewees, 2008; Abayomi and Yandle, 2012). Consolidation is also occurring in annual catch entitlement (Stewart and Callagher, 2011) and fish processing (Agnarsson, 2006; Bodwitch, 2017; Hass et al., 2016; McClintock et al., 2000).

The phenomenon of concentration can be viewed from multiple perspectives. As outlined above, studies have focused primarily on ITQs (or quota). This paper builds upon these studies by conducting an in-depth analysis of consolidation in New Zealand's inshore fishing sector. However, in addition to considering the level of quota (ITQ) concentration, it also examines catch

concentration (landings by fishers), and concentration of landed fish received by Licensed Fish Receivers (LFRs) (commonly referred to as fish *processors)*. The study examines the 18 most important inshore species (by value) using data for the 2017-18 fishing year.

In some cases, quota-owning LFRs rely on third party (i.e., independent) fishers to catch the ACE generated from the quota owned by the LFR. They may also buy ACE from non-fisher quota owners, potentially accumulating control over relatively large parcels of ACE. The quota aggregation limits mentioned above apply only to the perpetual rights represented by ITQs - there are no aggregation limits over ACE. And it is the Annual Catch Entitlement (ACE) derived from quota that ultimately controls catch. This means that an LFR could – through the accumulation of ACE – gain control over catch in excess of the quota aggregation limits. Thus, LFRs have the opportunity to gain a highly concentrated share of landed fish for any given species and could lead to an LFR gaining spatial monopoly power over catch and fish receiving for a species. This issue is examined below.

The requirement for fishers to balance landings against ACE means that a fisher without quota is reliant on third-party sources to maintain a supply of ACE. The necessity for fishers to source ACE has led to the establishment of enduring fisher-LFR relationships where non-quota-owning fishers land their catch to an LFR with the expectation that the LFR will sell them ACE to cover the catch. While this interchange allows the fisher to continue harvesting, the LFR benefits from the expertise of the fishers who efficiently harvest the catch derived from the LFRs quota (Stewart and Moriarity, 2017). However, there is no guarantee that an LFR will have sufficient quota (and

ACE) to cover all catch – this is particularly so for certain bycatch fishstocks. This places fishers under harvest constraints and creates an urgent search for alternative sources of the bycatch ACE, which often prove unfruitful. These situations make the acquisition, and accumulation of ACE a strategic goal – especially for LFRs as they seek to maintain or improve their share of the harvest of valuable fishstocks – a situation that leads to intense competition and high prices for key target species (Stewart and Lever, 2016).

The analysis provided in this study reveals the importance of not only examining concentration of ITQ and catch, but also the role of licensed fish receivers and the control they have over catch – a previously understudied aspect of consolidation in New Zealand fisheries. We contribute to the already extensive analysis of consolidation in New Zealand by providing a current analysis of consolidation in New Zealand's inshore fisheries, addressing concentration of quota ownership, catch, and fish receiving. We also compare our findings with earlier published analyses to assess how consolidation patterns have changed over time.

Methods

Data

Finfish species for inclusion in the study were selected from those identified in the Ministry of Fisheries Draft National Fisheries Plan for the Inshore Finfish (Ministry of Fisheries, 2011). The reported catch for the 2017-18 fishing year (in kg) for each of these finfish species plus selected shellfish were accessed from the Fisheries New Zealand Infosite[d]. These catch quantities were

[d] https:/fs.fish.govt.nz.

then multiplied by representative port prices provided by the Ministry for Primary Industries (MPI) to yield an estimate of the landed value for each species. The 18 species with the largest landed value were chosen for the study resulting in fifteen finfish and three shellfish species being included (see Table 1).

Table 1: The study's 18 inshore species sorted by estimated value.

Scientific name	Preferred commor name	Species code	Approximate landed value ($)
Jasus edwardsii	Rock Lobster	CRA	214,056,000
Pagrus auratus	Snapper	SNA	31,348,000
Haliotis iris, Haliotis australis	Paua	PAU	16,616,000
Nemadactylus macropterus	Tarakihi	TAR	15,503,000
Parapercis colias	Blue Cod	BCO	12,476,000
N/A	Flatfish	FLA	9,746,000
Chelidonichthys kumu	Red Gurnard	GUR	9,523,000
Galeorhinus galeus	School Shark	SCH	6,388,000
Ostrea chilensis	Oyster (Foveaux)	OYU	5,913,000
Mustelus lenticulatus	Rig	SPO	5,692,000
Polyprion oxygeneios, Polyprion americanus	Hapuku/Bass	HPB	5,399,000
Pseudocaranx georgianus	Trevally	TRE	4,773,000
Zeus faber	John Dory	JDO	4,003,000
Hyperoglyphe antarctica	Bluenose	BNS	3,345,000
Uranoscopidae spp.	Stargazer	STA	3,304,000
Callorhinchus milii	Elephant Fish	ELE	3,042,000
Mugil cephalus	Grey Mullet	GMU	2,951,000
Pseudophycis bachus	Red Cod	RCO	2,054,000

Ownership structure

Ownership structures of participants in the fishery exist in a variety of forms; sole traders, partnerships, trusts, private companies, public companies, and Mandated Iwi Organisations[e] (MIOs). It is relatively common for quota owners, fishers, and LFRs to operate using more than one entity, each with unique client identification numbers. In order to establish an accurate picture of concentration levels, the quota, catch, and LFR activity of 'associated entities' were amalgamated (Clement, 1996; Stewart and Callagher, 2011; Haas et al., 2016; Byrne et al., 2020). In the case of partnerships, entities with one or more partners in common were amalgamated. For companies, the New Zealand companies register was searched for each company and the directors were listed. Companies with one or more directors in common were considered to be associated companies. In some cases, information on major shareholders and holding company information was used to establish associations between companies.

In the case of MIOs, the name used by the quota-owning company, fisher or LFR does not always resemble the name of the MIO. Again, the companies register was searched to find the shareholder of the company – this is the specific MIO associated with that quota, catch or LFR. In a number of cases MIOs have created more than one entity – these are amalgamated for the purpose of establishing concentration levels.

[e] Mandated Iwi Organisations represent the 57 Māori tribes (Iwi) of New Zealand. They received commercial fisheries assets (quota shares) as part of the Treaty of Waitangi settlement negotiations, in accord with the Māori Fisheries Act.

The amalgamating of associated entities is critical to determining effective levels of concentration. The rationale for considering associated entities is based on the premise that directors have influence over decisions relating to the fishing operations of the companies they direct. It is not possible to establish the extent of such influence, but it is likely to be considerable in family-based alliances, and between subsidiary and holding companies. By combining the quota of two or more associated entities, the level of quota concentration for the amalgamated entity can exceed the quota aggregation limit laid out in the Fisheries regulations. This gives a more meaningful measure of concentration than a simple *prime facie* approach of just using the individual quota identification numbers (client ID) found in the quota registry – a single fisher may have several companies each with its own client ID.

Measures of concentration

The amalgamated entities were used to calculate concentration levels for quota ownership, catch and LFRs. Concentration ratios for the top 4 (CR4), top 10 (CR10), and top 20 (CR20) entities show the percentage share these groups hold of the total quota ownership, catch, or fish received.

A second measure of concentration, the Herfindahl-Hirschman Index (HHI) was also used to assess concentration. The HHI index is calculated by squaring each participant's share of the 'market' (in this case it is quota, catch and fish received) and then summing the results. An HHI of 10,000 would be the result for a monopoly (for example a firm owning 100 percent of the quota). Whereas the closer the HHI is to zero the less concentrated the market is. HHI scores have established interpretations; The U.S. Department of Justice and the Federal Trade

Commission (2010) state that an HHI index below 1,500 implies an unconcentrated market, an index between 1,500 and 2,500 indicates a moderately concentrated market, and an index above 2,500 indicates a highly concentrated market.

To establish concentration in the fish receiving sector, the largest LFRs across the 18 species were determined by awarding six points to the entity that received the most fish for a species, five points were awarded to the next largest entity, and so on down to one point for the sixth largest and zero points for all others. The points were then summed across the 18 species. Four LFRs received substantially more points than the others and are treated here as being the largest entities receiving fish in the inshore fishery.

Lorenz Curves (Lorenz 1905) were used to provide a visual depiction of concentration levels.

Findings

Concentration levels for quota ownership.

Table 2 provides concentration level measurements for quota ownership in the inshore fishery. The HHI results indicate that all species fall into the unconcentrated category. For shellfish, the CR10 ratio is above 90% for oyster but there are relatively few quota owners. For finfish, only trevally exceeds 70% at the CR4 level while seven species exceed 90% at the CR20 level. These levels of concentration are moderate relative to the levels observed by Stewart and Callagher (2011) in the middle depth and deepwater fisheries.

Table 2 also presents the number of entities allocated quota at the inception of the QMS (1986); the numbers ten years later (1996) and those in 2018. The quota registry records show both exit from, and entry into the QMS over the past three decades. However, it is evident that there has been a sharp decline in the overall number of entities owning quota. In some cases, this decline was as high as 70% (SPO) but averaged a 54% decline. The fall in the number of quota owners is even more meaningful when consideration is made for the off-market allocation of quota to the 57 Mandated Iwi Organisations. Previous studies have examined the nature and causes of the exodus from the QMS (Stewart and Walshe, 2008; Stewart et al., 2006; Yandle and Dewees, 2008). The exodus from quota ownership does, however, provide motivation for this comprehensive review of concentration in the inshore fishery.

Table 2: Concentration measures for entities owning quota.

Species	Number of Entities Allocated Quota 1986	Number of Quota Owning Entities 1996	Number of Quota Owning Entities 2018	% Decline in Quota Owning Entities 1986-2018	CR4	CR10	CR20	HHI
Shellfish								
CRA	…	…	390	…	0.381	0.482	0.568	421
OYU	…	…	14	…	0.591	0.904	1	1157
PAU	…	…	210	…	0.567	0.645	0.72	1261
Finfish								
BCO	560	370	248	55.71	0.362	0.596	0.718	461
BNS	194	135	130	32.99	0.609	0.796	0.888	1060
ELE	249	146	108	56.63	0.592	0.819	0.917	1116
FLA	667	462	247	62.97	0.472	0.663	0.758	744
GMU	173	169	126	27.17	0.456	0.682	0.856	731
GUR	710	431	231	67.46	0.592	0.766	0.862	1002
HPB	630	368	232	63.17	0.463	0.713	0.818	708
JDO	309	199	131	57.61	0.659	0.833	0.911	1241
RCO	415	272	166	60.0	0.64	0.83	0.917	1120
SCH	816	428	255	68.75	0.432	0.667	0.787	609
SNA	243	341	207	14.81	0.619	0.816	0.908	1050
SPO	729	407	218	70.1	0.484	0.678	0.807	738
STA	256	166	124	51.56	0.56	0.779	0.9	933
TAR	513	309	188	63.35	0.574	0.823	0.908	1027
TRE	452	277	172	61.95	0.731	0.87	0.937	1388

(Finfish data for 1986 and 1996 sourced from Clements, 1996. Shellfish stocks entered the QMS at differing dates).

Concentration levels for fishers

Table 3 sets out the levels of concentration for entities catching fish. The HHI for oyster indicates it is unconcentrated, but because there are only eleven fishers catching oyster the CR10 is 98%. For finfish the HHI figures in Table 3 indicate that catch concentration levels for all species apart from trevally are unconcentrated. The result for trevally is highly concentrated with an HHI of

3209. Its CR4 ratio shows that the top four entities catch close to 80% of trevally. Only two of the CR20 ratios for finfish exceed 90% (bluenose and trevally).

Table 3: Concentration measures for entities catching fish

Species	Number of Entities	CR4	CR10	CR20	HHI
Shellfish					
CRA	254	0.083	0.166	0.27	72
OYU	11	0.533	0.981	1	1100
PAU	74	0.212	0.392	0.61	261
Finfish					
BCO	278	0.107	0.225	0.382	125
BNS	80	0.515	0.806	0.929	988
ELE	121	0.394	0.628	0.789	605
FLA	263	0.132	0.278	0.451	145
GMU	101	0.268	0.525	0.748	372
GUR	255	0.263	0.424	0.589	294
HPB	186	0.29	0.499	0.683	355
JDO	160	0.325	0.516	0.713	479
RCO	184	0.369	0.595	0.753	535
SCH	249	0.282	0.508	0.678	349
SNA	195	0.446	0.602	0.742	810
SPO	298	0.253	0.404	0.541	276
STA	135	0.325	0.58	0.785	450
TAR	197	0.319	0.57	0.774	424
TRE	201	0.792	0.891	0.946	3209

Concentration levels for licenced fish receivers

The concentration results for licenced fish receivers, reported in Table 4, show a more concentrated structure than for quota ownership and catch. The commercially important rock lobster species rates as a moderately concentrated LFR structure (HHI of 1858) while paua falls in the unconcentrated range with an HHI of 1250. The LFR concentration for the finfish fishery

is also more concentrated than for quota and catch. Five species (elephant fish, flatfish, snapper, stargazer, and trevally) have a highly concentrated structure as measured by the HHI. A further four species (bluenose, grey mullet, john dory and red cod) fall within the moderately concentrated range. The remaining six (blue cod, gurnard, hapuku/bass, school shark, rig and tarakihi) are unconcentrated.

Table 4: Concentration measures for entities receiving fish.

Species	Number of Entities	CR4	CR10	CR20	HHI
Shellfish					
CRA	29	0.771	0.936	0.999	1858
OYU	4	1	1	1	4685
PAU	22	0.638	0.939	0.999	1250
Finfish					
BCO	61	0.452	0.789	0.964	775
BNS	32	0.721	0.959	0.996	1766
ELE	32	0.892	0.986	0.998	3112
FLA	54	0.646	0.851	0.944	1765
GMU	38	0.664	0.852	0.973	2489
GUR	66	0.66	0.869	0.967	1410
HPB	53	0.521	0.768	0.898	869
JDO	39	0.792	0.941	0.994	1923
RCO	46	0.778	0.945	0.989	2156
SCH	58	0.654	0.899	0.981	1410
SNA	56	0.907	0.962	0.991	2768
SPO	71	0.588	0.862	0.964	1287
STA	36	0.799	0.97	0.997	2508
TAR	58	0.646	0.918	0.983	1262
TRE	56	0.894	0.956	0.986	4154

Seven of the CR4 ratios exceed 70%, with one (snapper) exceeding 90%. At the CR20 level, fourteen of the fifteen species exceed 90%. These are much higher concentration levels than

for quota ownership or fishers (i.e., catch).

Role of four largest licenced fish receivers

Table 5 was prepared to determine whether large LFRs (and their associated entities) also play a significant role in the ownership of quota and in the catch of fish. For shellfish the four large LFRs own modest amounts of quota for each species but they only catch oyster and only receive Paua, both in modest amounts. Thus, their role for shellfish is not very significant.

Their role for finfish is quite different. They receive more than 50% of all finfish species except for blue cod. They also own more than 20% of the quota for all species except grey mullet (and more than 40% of the quota for eight of the species). However, with the exception of trevally, their share of the catch for all species is modest. They catch less than 5% of the fish for five species, their catch is less than 10% for another 3 species and less than 25% for six additional species. Thus, these four entities have a significant role for quota ownership and the receiving of fish, but only a modest role for the actual catch of fish.

Table 5: Percentages of market held by the four largest LFRs and their affiliates.

Species	Quota Owned	Fish Caught	Fish Received
Shellfish			
CRA	14.2	0.0	1.4
OYU	13	20.7	0.0
PAU	29.2	0.0	17.4
Finfish			
BCO	22.5	0.3	27.1
BNS	38.7	16.6	55.5
ELE	40.7	4.4	83.4
FLA	28.9	0.7	56.7
GMU	9.8	0.0	51.0
GUR	43.8	9.3	66.0
HPB	34.5	8.2	52.1
JDO	41.6	16.6	74.1
RCO	45.8	20.1	73.6
SCH	31.8	10.5	60.7
SNA	46.3	24.5	72.1
SPO	33.2	4.2	58.8
STA	46.8	13.4	74.4
TAR	46.0	7.5	64.5
TRE	54.9	53.5	86.9

A graphical representation of concentration levels

Tables 2 through 4 have presented numerical measurements of concentration levels for quota owners, fishers and LFRs.

To represent all 18 of the species in the study by a single Lorenz Curve the species were combined using representative port prices to estimate their relative market value. Thus, market share for a given percentage of quota owners is measured by the estimated market value they own as a percentage of the estimated market value for all quota. Similar calculations were made for fisher's catch and fish received by LFRs. A selection of the data points is presented in

Table 6. The full resulting plots are shown in Figure 1.

Table 6: Selected data points plotted by the Lorenz Curves.

Percent of Smallest Owners/Fishers/LFRs	Percent Estimated Value of Quota	Catch Percent of Estimated Fish Value	Receive Percent of Estimated Fish Value
20	0.1	0.5	0.04
40	1.2	3.7	0.3
80	15.0	37.2	6.8
90	24.9	56.0	20.1
94	32.0	66.9	31.5
98	44.7	83.0	59.3
100	100.0	100.0	100.0

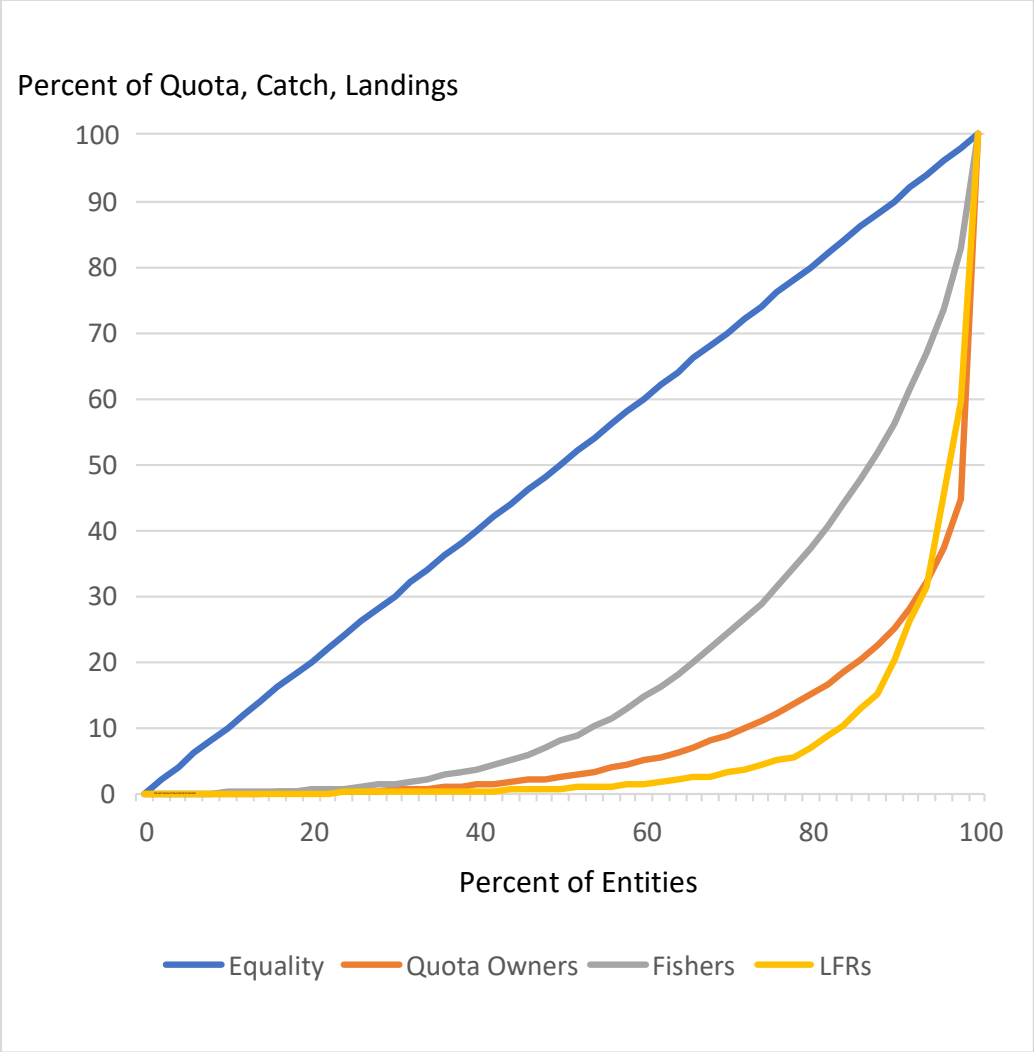

Figure 1 Lorenz Curves for Quota, Catch and LFR concentration.

The Lorenz Curves in Figure 1 provide visual confirmation that quota ownership in the inshore fishery is more concentrated than fishers' catch and that LFRs are generally more concentrated at all but the top extreme percentage of entities.

Discussion

The 15 inshore finfish species have an average of 193 active fishers. Thirteen of the species have a catch CR20 in excess of 54% and 10 species have a CR10 in excess of 50%. These results show that there are numerous smaller fishers co-existing with larger-scale fishers. Unlike the deepwater fishery, the results suggest that economies of scale are not a dominant force in the inshore fishery.

The middle depth and deepwater fleet are comprised of larger vessels, capable of coping with rougher seas and staying at sea for extended periods of time[f]. The presence of economies of scale drives rationalization, leading to fewer and larger vessels (Stewart and Callagher, 2011, Nielsen et al., 2021). The aggregation limits for deepwater fishstocks (45% for hoki and orange roughy, for example) also encourage scale, enabling fishers to accumulate a greater share of quota as a means of increasing catch. Consequently, quota concentration for commercially important deepwater species, such as hoki and orange roughy, exceed 80% at the CR4 level (Stewart and Callagher, 2011). This is considerably more concentrated than any of the inshore fisheries reported. Sanford, New Zealand's only publicly listed fishing company, reports that their fleet is comprised of 15 vessels (only 4 of which are inshore) in addition they report having 444

[f] See for example https://www.sanford.co.nz/operations/fishing/fleet/)

independent fishers who catch for them[g]. Other major seafood operators provide a similar breakdown for their inshore versus offshore fishing effort[h].

Although there is a presence of larger operators in the inshore fishery, the small fisher is still a significant force. Many of these fishers operate single vessels with 2 or 3 crew. It is evident that inshore fishers possess considerable fishing expertise. A fact that is acknowledged by the quota-owning LFRs who supply ACE to fishers in return for the catch landed to them. Some large LFRs who fish the middle-depth and deepwater fisheries choose not to fish the inshore fishery, instead relying on the fleet of inshore fishers to catch their ACE (Stewart and Moriarity, 2017). Many of these fisher-LFR relationships have endured for decades, perhaps because of the thin market for ACE leaving fishers with few options but also because of the mutual benefit derived from a stable business arrangement that neither partly wants to disrupt.

The levels of concentration for fish receiving are higher than for either catch or quota ownership (see Figure 1 and Table 5). The top 20 LFRs approach close to 100% of finfish received for a number of species. Looking at the four largest LFRs shows that while they own a sizeable proportion of the quota for most species (an average of 38% each for finfish) their share of the finfish catch is – with the exception of trevally – relatively low (12.6 % of catch each on average per species). This highlights their dependence on smaller fishers to catch for them. Their combined share of finfish species received is high; at an average of 63% each per finfish species. This presents a picture of an inshore fishery which has a small number of LFRs who rely on a relatively large number of fishers (many of small scale) to catch for them.

[g] https://www.sanford.co.nz/operations/fishing/fleet/
[h] https://www.talleys.co.nz/about-us

This picture suggests that a degree of specialisation has developed across the inshore fishery, with a measure of interdependence. The small ACE-reliant fishers need access to ACE to allow them to balance their catch, while the LFRs rely on the expertise of local fishers to do the work of harvesting. The LFRs in turn assist the small fishers by providing timely transfers of ACE to enable catch balancing (Stewart and Moriarity, 2017). LFRs and their independent fisher affiliates generally meet at the beginning of each fishing year to discuss catch plans that guide skippers in determining optimal catch portfolios, including which species to target and which bycatch to avoid due to the likelihood of ACE limitations (Stewart and Moriarity, 2017).

The ACE mechanism is pivotal in coordinating the LFR-fisher-quota owner functions. A key attribute of the ACE mechanism is the very low transaction cost for ACE transfers and the availability of information – all participants can see where unused ACE exists and can contact holders of unused ACE to pursue acquisition. Consequently, the New Zealand ITQ system, with its ACE regime, allows catch-balancing to work effectively, and facilitates the use of expert fishers to catch, while allowing LFRs to process and market fish, both locally and for export. Having an ITQ system with a low transaction-cost means of transferring catch shares (e.g., ACE) is seen as one of the main drivers of efficiency, see for example, Arnason, 1993; Herrmann, 1996; Kerr, 2004; Knapp, 1997; Grafton et al., 2000; Hartley and Fina, 2001; Newell et al., 2005; Grimm et al., 2012, Innes et al., 2014; Stewart and Leaver, 2016, Townsend and Walker, 2022.

The long-standing nature of LFR-fisher relationships creates an insider-outsider dichotomy; it is difficult for new entrants to access ACE for valuable target species and critical bycatch stock, ultimately restricting entry (Stewart and Lever, 2016). So, while the LFR needs the fisher's

expertise to land the fish, the LFR ultimately holds the ace-card; literally the holder of ACE dictates who will catch the fish.

An LFR with a substantial holding of ACE for a key bycatch fishstock holds considerable market power. They can influence who is able to fish for target species for which bycatch ACE is in short supply (for example, elephant fish in fisheries management area 3 (FMA3) Stewart and Moriarity, 2017).

In the absence of ACE, a fisher must pay a deemed value fee for fish landed without ACE. For many fishstocks, deemed value rates are progressive, increasing in line with levels of overfishing. In cases where a fisher has a high level of bycatch, for which they have no ACE, escalating deemed value fees may make a fisher's entire catch uneconomic (Walker and Townsend, 2008; Pascoe et al., 2010; Stewart and Lever, 2015 and 2016, Townsend and Walker, 2022).

An open market exists for ACE, where fishers can seek additional ACE, such as via quota brokers. However, ACE for problematic bycatch species, or valuable target species, is unlikely to be available in significant quantity and when it is available the price will be driven up due to excess demand (Stewart and Lever, 2015). The high price of quota and the constrained supply of ACE create barriers to entry, ultimately limiting the size of the inshore fleet. Small fishers also report that high compliance costs associated with the quota management system are a major factor contributing to decisions to exit from the fishery (Stewart et al., 2006 and Stewart and Walshe, 2008). This fact may contribute to the decision by some to participate as ACE-only fishers. It also

contributes to a low level of new entrants and conversely the tendency for fishers to pursue lifetime careers as fishers – a fact contributing to the expertise gained from many years of experience (Stewart et al., 2008).

Limitations and further research

The study considered 18 important inshore species using common measures of concentration at the species level. Accounting for associated entities provided an understanding of concentration from the point of view of effective control over quota and ACE for species under the QMS.

Further research is needed to examine concentration at the fishstock level. Most of the species studied have a number of separate fishstocks each with designated quota management areas (QMA), the quota and ACE of which are not transferable between QMAs. It is therefore possible for a single quota holder to have monopoly control over a particular fishstock and still not exceed the aggregation limit set for the species itself – effectively a spatial monopoly. Such a situation would give the entity (such as a quota-owning LFR) considerable market power over that fishstock's fishery. Since self employed fishers tend to fish in a single fisheries management area (FMA) the existence of a single source of ACE (monopoly) and single fish receiver (monopsony) gives considerable power to the LFR and little bargaining power to fishers who own no quota.

Conclusion

This study has examined 18 commercially important inshore finfish and shellfish species. Concentration levels for quota ownership are classified as 'unconcentrated'. The level of concentration for actual catch by fishers is also 'unconcentrated' for all species except trevally.

These levels of concentration are lower than those observed previously in the middle-depth and deepwater fisheries. However, licenced fish receiving for inshore species is noticeably more concentrated than for quota ownership and catch with five species being highly concentrated, five moderately concentrated, and seven unconcentrated. Highly concentrated markets for fish receiving, such as duopsony or oligopsony, where there are only two or a few buyers, limit the fishers' options for selling fish. If these buyers also control a large percentage of quota, they can also exert significant control over catch by limiting the sale of ACE to fishers who land to them. However, at this point, neither of these conditions seem to be at critical levels in the inshore fishery. Nevertheless, continued rivalry between LFRs is key to providing ACE-only fishers a fair return for fish landed.

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Consolidation and control in the New Zealand quota managed inshore fishery.

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Abstract

The introduction of individual transferable quotas to the New Zealand fishery has seen the gradual concentration of both quota ownership and catch – especially in the deepwater fishery. This paper examines the levels of concentration of quota ownership, catch and fish receiving (by fish processors) for the top 18 species in New Zealand's inshore fishery. It uses concentration ratios, the Herfindahl-Hirschman Index and the Lorenz curve to measure and compare the levels of consolidation. The study combines 'associated entities' (companies with common directors) when measuring concentration. Using internationally recognized benchmarks for concentration, the New Zealand inshore fishery is assessed to be unconcentrated in quota ownership and catch but relatively more concentrated in fish receiving. It is evident that quota-owning licenced fish receivers typically rely on self-employed fishers to fish their quota. This enables fishers without quota to continue operating, and also allows fish receivers to benefit from the expertise of career fishers.

Keywords: Quota management system, consolidation, control, catch shares, fishers.
Q22, Q28.

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Introduction

The condition of the world's marine fisheries has become an area of increasing concern over the last forty years or more. Governments have experimented with a variety of regulatory tools to limit both overfishing and adverse ecological effects of fishing. One approach to reducing overfishing that has attracted extensive research and policy attention is the adoption of Individual Transferrable Quotas – or ITQs (Chu, 2009; Arnason, 2002; Costello et al., 2008; Grafton, 1996a, Young et al., 2018). ITQs are used in a variety of countries including: Iceland (Arnason, 2005; Byrne et al., 2020; Chambers and Carothers, 2017; Eythórsson, 2000; Gunnlaugsson et al., 2020), Norway (Hannesson, 2013 and 2017; Standal and Asche, 2018), the United States (Holland et al., 2017; Hsueh and Kasperski, 2018; Brewer et al., 2017; Carothers and Chambers, 2017), Canada (Edwards and Pinkerton, 2020; Hoshino et al., 2020), Chile (Kroetz et al., 2017), Australia (Pascoe et al., 2020; Kawamoto and Baba, 2020; Innes et al., 2014), and New Zealand (Hersoug, 2018; Kerr, 2004; Stewart et al., 2006; Yandle and Dewees, 2008).

Upon adoption of an ITQs regime, the government allocates a specified proportion of the Total Allowable Catch (TAC) of a fishery to fishers or fishing companies (usually based on catch history). The allocated ITQ can then be sold or otherwise transferred between market participants. This transferability provides a mechanism for fishers to choose to exit a fishery (Byrne et al., 2020; Grafton, 1996b; Stewart et al., 2006), allowing a more orderly reduction of effort in the fishery. This characteristic and the incentives it creates (as well as the criteria for making the initial allocation) are central to the extensive debate over the positive and negative effects of ITQs (See, for example, Arnason, 2012; Carothers and Chambers, 2012; Chu, 2009; Copes, 1986; Costello et

al., 2008; McCay, 1995 and 2004; Pinkerton and Edwards, 2009, Sumaila, 2010; Young et al., 2018.)

One key area of concern is consolidation: the concentration of a high percentage of catching rights in the hands of only a few fishery participants. Consolidation raises concerns over market power, and social welfare (Abayomi and Yandle, 2012; Helgesen, 2022). Market power refers to concerns that conditions may encourage a non-competitive market to develop for product, quota, or labour (Byrne et al., 2020; McEvoy et al., 2009; Grainger and Parker, 2013). Social welfare concerns are most commonly raised about consolidation. These focus on the shift of wealth and fishery control from local (particularly indigenous) communities (Bodwitch, 2017; Carothers, 2015; Mccormack, 2016).

Because of these concerns, most ITQ regimes (including New Zealand) place upper limits on the consolidation of quota (Byrne et al., 2020; Dewees, 1998; Sanchirico et al., 2006). As we discuss below, New Zealand is a particularly dynamic case for understanding consolidation issues under ITQs.

New Zealand Quota Management System (QMS)

New Zealand has a significant presence in the fisheries management literature. New Zealand's Quota Management System (QMS) covers the commercial fishing of 98 species or species groups (spread over 642 fish stocks) inside the country's Economic Exclusion Zone (EEZ). The New Zealand EEZ is roughly 1.2 million square nautical miles, the fourth largest in the world. The

industry is responsible for NZ$ 2 billion in exports, consisting of 267,901 tonne of seafood exports in 2018 (Seafood, 2021)

The New Zealand fishery is divided into two distinct sectors. The deepwater sector targets species including orange roughy, squid, hake, and hoki. It is dominated by a small number of large vertically integrated harvesting and processing companies. The inshore sector targets a variety of species including snapper, flounder, rock lobster, and gurnard. Harvesters in the inshore fisheries consist mostly of independent small-scale fishers who sell their catch to the vertically integrated companies; and by boats that are owned by the vertically integrated companies with hired crews (Yandle and Dewees, 2008; Stewart and Moriarity, 2017). New Zealand became one of the first countries to introduce ITQ management in 1986, a time when the offshore sector was rapidly expanding, and the inshore sector was facing retrenchment (Yandle and Dewees, 2008). The inshore sector is the focus of this study.

Much of the literature on New Zealand's QMS focuses on 1) describing the approach taken (Clark et al., 1988; Annala, 1996); 2) the assessment of its economic and scientific performance (Batstone and Sharp, 1999; Bisack et al., 2006; Mace et al., 2014) and 3) a debate over the social consequences of the QMS (Boyd and Dewees, 1992; Yandle and Dewees, 2003; Stewart et al., 2006; Stewart and Callagher, 2011; Simmons and Stringer, 2014). Closely related are discussions of the impact that the QMS has had on New Zealand's indigenous Māori communities. This impact was recognized relatively early (Memon and Cullen, 1992) and led to explicit incorporation of Māori rights into both the commercial ITQ system and the creation of customary

catching rights (Inns, 2013; Yandle, 2007). This process, and the challenges faced by Māori in fisheries management are well described and analyzed in Bodwitch 2017.

One highly studied issue in New Zealand fisheries management (and one of the topics of this analysis) is limitations placed on the consolidation of ITQs. With aggregation limits varying from 10% for spiny rock lobster to 35% for certain offshore species (Fisheries Act, 1996), New Zealand's consolidation limits are among the least restrictive. This makes New Zealand an excellent case for understanding how consolidation happens in an ITQ management system. Early attention on consolidation began appearing in the 1990s (Bevin et al., 1990; Dewees, 1998). The first statistical analysis (Connor, 2000) showed that consolidation was indeed occurring, but not at the rate anticipated. Further analyses documented the effects of consolidation on small-scale fishers (Stewart and Walshe, 2008; Stewart et al., 2006) and argued that consolidation was the logical consequence of a functioning ITQ market (Newell et al., 2005). Consolidation of ITQ ownership clearly occurs, but its intensity varies between location of fishery, whether it is export-oriented, and by point in time, (Yandle and Dewees, 2008; Abayomi and Yandle, 2012). Consolidation is also occurring in annual catch entitlement (Stewart and Callagher, 2011) and fish processing (Agnarsson, 2006; Bodwitch, 2017; Hass et al., 2016; McClintock et al., 2000).

The phenomenon of concentration can be viewed from multiple perspectives. As outlined above, studies have focused primarily on ITQs (or quota). This paper builds upon these studies by conducting an in-depth analysis of consolidation in New Zealand's inshore fishing sector. However, in addition to considering the level of quota (ITQ) concentration, it also examines catch

concentration (landings by fishers), and concentration of landed fish received by Licensed Fish Receivers (LFRs) (commonly referred to as fish *processors)*. The study examines the 18 most important inshore species (by value) using data for the 2017-18 fishing year.

In some cases, quota-owning LFRs rely on third party (i.e., independent) fishers to catch the ACE generated from the quota owned by the LFR. They may also buy ACE from non-fisher quota owners, potentially accumulating control over relatively large parcels of ACE. The quota aggregation limits mentioned above apply only to the perpetual rights represented by ITQs - there are no aggregation limits over ACE. And it is the Annual Catch Entitlement (ACE) derived from quota that ultimately controls catch. This means that an LFR could – through the accumulation of ACE – gain control over catch in excess of the quota aggregation limits. Thus, LFRs have the opportunity to gain a highly concentrated share of landed fish for any given species and could lead to an LFR gaining spatial monopoly power over catch and fish receiving for a species. This issue is examined below.

The requirement for fishers to balance landings against ACE means that a fisher without quota is reliant on third-party sources to maintain a supply of ACE. The necessity for fishers to source ACE has led to the establishment of enduring fisher-LFR relationships where non-quota-owning fishers land their catch to an LFR with the expectation that the LFR will sell them ACE to cover the catch. While this interchange allows the fisher to continue harvesting, the LFR benefits from the expertise of the fishers who efficiently harvest the catch derived from the LFRs quota (Stewart and Moriarity, 2017). However, there is no guarantee that an LFR will have sufficient quota (and

ACE) to cover all catch – this is particularly so for certain bycatch fishstocks. This places fishers under harvest constraints and creates an urgent search for alternative sources of the bycatch ACE, which often prove unfruitful. These situations make the acquisition, and accumulation of ACE a strategic goal – especially for LFRs as they seek to maintain or improve their share of the harvest of valuable fishstocks – a situation that leads to intense competition and high prices for key target species (Stewart and Lever, 2016).

The analysis provided in this study reveals the importance of not only examining concentration of ITQ and catch, but also the role of licensed fish receivers and the control they have over catch – a previously understudied aspect of consolidation in New Zealand fisheries. We contribute to the already extensive analysis of consolidation in New Zealand by providing a current analysis of consolidation in New Zealand's inshore fisheries, addressing concentration of quota ownership, catch, and fish receiving. We also compare our findings with earlier published analyses to assess how consolidation patterns have changed over time.

Methods

Data

Finfish species for inclusion in the study were selected from those identified in the Ministry of Fisheries Draft National Fisheries Plan for the Inshore Finfish (Ministry of Fisheries, 2011). The reported catch for the 2017-18 fishing year (in kg) for each of these finfish species plus selected shellfish were accessed from the Fisheries New Zealand Infosite[d]. These catch quantities were

[d] https:/fs.fish.govt.nz.

then multiplied by representative port prices provided by the Ministry for Primary Industries (MPI) to yield an estimate of the landed value for each species. The 18 species with the largest landed value were chosen for the study resulting in fifteen finfish and three shellfish species being included (see Table 1).

Table 1: The study's 18 inshore species sorted by estimated value.

Scientific name	Preferred commor name	Species code	Approximate landed value ($)
Jasus edwardsii	Rock Lobster	CRA	214,056,000
Pagrus auratus	Snapper	SNA	31,348,000
Haliotis iris, Haliotis australis	Paua	PAU	16,616,000
Nemadactylus macropterus	Tarakihi	TAR	15,503,000
Parapercis colias	Blue Cod	BCO	12,476,000
N/A	Flatfish	FLA	9,746,000
Chelidonichthys kumu	Red Gurnard	GUR	9,523,000
Galeorhinus galeus	School Shark	SCH	6,388,000
Ostrea chilensis	Oyster (Foveaux)	OYU	5,913,000
Mustelus lenticulatus	Rig	SPO	5,692,000
Polyprion oxygeneios, Polyprion americanus	Hapuku/Bass	HPB	5,399,000
Pseudocaranx georgianus	Trevally	TRE	4,773,000
Zeus faber	John Dory	JDO	4,003,000
Hyperoglyphe antarctica	Bluenose	BNS	3,345,000
Uranoscopidae spp.	Stargazer	STA	3,304,000
Callorhinchus milii	Elephant Fish	ELE	3,042,000
Mugil cephalus	Grey Mullet	GMU	2,951,000
Pseudophycis bachus	Red Cod	RCO	2,054,000

Ownership structure

Ownership structures of participants in the fishery exist in a variety of forms; sole traders, partnerships, trusts, private companies, public companies, and Mandated Iwi Organisations[e] (MIOs). It is relatively common for quota owners, fishers, and LFRs to operate using more than one entity, each with unique client identification numbers. In order to establish an accurate picture of concentration levels, the quota, catch, and LFR activity of 'associated entities' were amalgamated (Clement, 1996; Stewart and Callagher, 2011; Haas et al., 2016; Byrne et al., 2020). In the case of partnerships, entities with one or more partners in common were amalgamated. For companies, the New Zealand companies register was searched for each company and the directors were listed. Companies with one or more directors in common were considered to be associated companies. In some cases, information on major shareholders and holding company information was used to establish associations between companies.

In the case of MIOs, the name used by the quota-owning company, fisher or LFR does not always resemble the name of the MIO. Again, the companies register was searched to find the shareholder of the company – this is the specific MIO associated with that quota, catch or LFR. In a number of cases MIOs have created more than one entity – these are amalgamated for the purpose of establishing concentration levels.

[e] Mandated Iwi Organisations represent the 57 Māori tribes (Iwi) of New Zealand. They received commercial fisheries assets (quota shares) as part of the Treaty of Waitangi settlement negotiations, in accord with the Māori Fisheries Act.

The amalgamating of associated entities is critical to determining effective levels of concentration. The rationale for considering associated entities is based on the premise that directors have influence over decisions relating to the fishing operations of the companies they direct. It is not possible to establish the extent of such influence, but it is likely to be considerable in family-based alliances, and between subsidiary and holding companies. By combining the quota of two or more associated entities, the level of quota concentration for the amalgamated entity can exceed the quota aggregation limit laid out in the Fisheries regulations. This gives a more meaningful measure of concentration than a simple *prime facie* approach of just using the individual quota identification numbers (client ID) found in the quota registry – a single fisher may have several companies each with its own client ID.

Measures of concentration

The amalgamated entities were used to calculate concentration levels for quota ownership, catch and LFRs. Concentration ratios for the top 4 (CR4), top 10 (CR10), and top 20 (CR20) entities show the percentage share these groups hold of the total quota ownership, catch, or fish received.

A second measure of concentration, the Herfindahl-Hirschman Index (HHI) was also used to assess concentration. The HHI index is calculated by squaring each participant's share of the 'market' (in this case it is quota, catch and fish received) and then summing the results. An HHI of 10,000 would be the result for a monopoly (for example a firm owning 100 percent of the quota). Whereas the closer the HHI is to zero the less concentrated the market is. HHI scores have established interpretations; The U.S. Department of Justice and the Federal Trade

Commission (2010) state that an HHI index below 1,500 implies an unconcentrated market, an index between 1,500 and 2,500 indicates a moderately concentrated market, and an index above 2,500 indicates a highly concentrated market.

To establish concentration in the fish receiving sector, the largest LFRs across the 18 species were determined by awarding six points to the entity that received the most fish for a species, five points were awarded to the next largest entity, and so on down to one point for the sixth largest and zero points for all others. The points were then summed across the 18 species. Four LFRs received substantially more points than the others and are treated here as being the largest entities receiving fish in the inshore fishery.

Lorenz Curves (Lorenz 1905) were used to provide a visual depiction of concentration levels.

Findings

Concentration levels for quota ownership.

Table 2 provides concentration level measurements for quota ownership in the inshore fishery. The HHI results indicate that all species fall into the unconcentrated category. For shellfish, the CR10 ratio is above 90% for oyster but there are relatively few quota owners. For finfish, only trevally exceeds 70% at the CR4 level while seven species exceed 90% at the CR20 level. These levels of concentration are moderate relative to the levels observed by Stewart and Callagher (2011) in the middle depth and deepwater fisheries.

Table 2 also presents the number of entities allocated quota at the inception of the QMS (1986); the numbers ten years later (1996) and those in 2018. The quota registry records show both exit from, and entry into the QMS over the past three decades. However, it is evident that there has been a sharp decline in the overall number of entities owning quota. In some cases, this decline was as high as 70% (SPO) but averaged a 54% decline. The fall in the number of quota owners is even more meaningful when consideration is made for the off-market allocation of quota to the 57 Mandated Iwi Organisations. Previous studies have examined the nature and causes of the exodus from the QMS (Stewart and Walshe, 2008; Stewart et al., 2006; Yandle and Dewees, 2008). The exodus from quota ownership does, however, provide motivation for this comprehensive review of concentration in the inshore fishery.

Table 2: Concentration measures for entities owning quota.

Species	Number of Entities Allocated Quota 1986	Number of Quota Owning Entities 1996	Number of Quota Owning Entities 2018	% Decline in Quota Owning Entities 1986-2018	CR4	CR10	CR20	HHI
Shellfish								
CRA	…	…	390	…	0.381	0.482	0.568	421
OYU	…	…	14	…	0.591	0.904	1	1157
PAU	…	…	210	…	0.567	0.645	0.72	1261
Finfish								
BCO	560	370	248	55.71	0.362	0.596	0.718	461
BNS	194	135	130	32.99	0.609	0.796	0.888	1060
ELE	249	146	108	56.63	0.592	0.819	0.917	1116
FLA	667	462	247	62.97	0.472	0.663	0.758	744
GMU	173	169	126	27.17	0.456	0.682	0.856	731
GUR	710	431	231	67.46	0.592	0.766	0.862	1002
HPB	630	368	232	63.17	0.463	0.713	0.818	708
JDO	309	199	131	57.61	0.659	0.833	0.911	1241
RCO	415	272	166	60.0	0.64	0.83	0.917	1120
SCH	816	428	255	68.75	0.432	0.667	0.787	609
SNA	243	341	207	14.81	0.619	0.816	0.908	1050
SPO	729	407	218	70.1	0.484	0.678	0.807	738
STA	256	166	124	51.56	0.56	0.779	0.9	933
TAR	513	309	188	63.35	0.574	0.823	0.908	1027
TRE	452	277	172	61.95	0.731	0.87	0.937	1388

(Finfish data for 1986 and 1996 sourced from Clements, 1996. Shellfish stocks entered the QMS at differing dates).

Concentration levels for fishers

Table 3 sets out the levels of concentration for entities catching fish. The HHI for oyster indicates it is unconcentrated, but because there are only eleven fishers catching oyster the CR10 is 98%. For finfish the HHI figures in Table 3 indicate that catch concentration levels for all species apart from trevally are unconcentrated. The result for trevally is highly concentrated with an HHI of

3209. Its CR4 ratio shows that the top four entities catch close to 80% of trevally. Only two of the CR20 ratios for finfish exceed 90% (bluenose and trevally).

Table 3: Concentration measures for entities catching fish

Species	Number of Entities	CR4	CR10	CR20	HHI
Shellfish					
CRA	254	0.083	0.166	0.27	72
OYU	11	0.533	0.981	1	1100
PAU	74	0.212	0.392	0.61	261
Finfish					
BCO	278	0.107	0.225	0.382	125
BNS	80	0.515	0.806	0.929	988
ELE	121	0.394	0.628	0.789	605
FLA	263	0.132	0.278	0.451	145
GMU	101	0.268	0.525	0.748	372
GUR	255	0.263	0.424	0.589	294
HPB	186	0.29	0.499	0.683	355
JDO	160	0.325	0.516	0.713	479
RCO	184	0.369	0.595	0.753	535
SCH	249	0.282	0.508	0.678	349
SNA	195	0.446	0.602	0.742	810
SPO	298	0.253	0.404	0.541	276
STA	135	0.325	0.58	0.785	450
TAR	197	0.319	0.57	0.774	424
TRE	201	0.792	0.891	0.946	3209

Concentration levels for licenced fish receivers

The concentration results for licenced fish receivers, reported in Table 4, show a more concentrated structure than for quota ownership and catch. The commercially important rock lobster species rates as a moderately concentrated LFR structure (HHI of 1858) while paua falls in the unconcentrated range with an HHI of 1250. The LFR concentration for the finfish fishery

is also more concentrated than for quota and catch. Five species (elephant fish, flatfish, snapper, stargazer, and trevally) have a highly concentrated structure as measured by the HHI. A further four species (bluenose, grey mullet, john dory and red cod) fall within the moderately concentrated range. The remaining six (blue cod, gurnard, hapuku/bass, school shark, rig and tarakihi) are unconcentrated.

Table 4: Concentration measures for entities receiving fish.

Species	Number of Entities	CR4	CR10	CR20	HHI
Shellfish					
CRA	29	0.771	0.936	0.999	1858
OYU	4	1	1	1	4685
PAU	22	0.638	0.939	0.999	1250
Finfish					
BCO	61	0.452	0.789	0.964	775
BNS	32	0.721	0.959	0.996	1766
ELE	32	0.892	0.986	0.998	3112
FLA	54	0.646	0.851	0.944	1765
GMU	38	0.664	0.852	0.973	2489
GUR	66	0.66	0.869	0.967	1410
HPB	53	0.521	0.768	0.898	869
JDO	39	0.792	0.941	0.994	1923
RCO	46	0.778	0.945	0.989	2156
SCH	58	0.654	0.899	0.981	1410
SNA	56	0.907	0.962	0.991	2768
SPO	71	0.588	0.862	0.964	1287
STA	36	0.799	0.97	0.997	2508
TAR	58	0.646	0.918	0.983	1262
TRE	56	0.894	0.956	0.986	4154

Seven of the CR4 ratios exceed 70%, with one (snapper) exceeding 90%. At the CR20 level, fourteen of the fifteen species exceed 90%. These are much higher concentration levels than

for quota ownership or fishers (i.e., catch).

Role of four largest licenced fish receivers

Table 5 was prepared to determine whether large LFRs (and their associated entities) also play a significant role in the ownership of quota and in the catch of fish. For shellfish the four large LFRs own modest amounts of quota for each species but they only catch oyster and only receive Paua, both in modest amounts. Thus, their role for shellfish is not very significant.

Their role for finfish is quite different. They receive more than 50% of all finfish species except for blue cod. They also own more than 20% of the quota for all species except grey mullet (and more than 40% of the quota for eight of the species). However, with the exception of trevally, their share of the catch for all species is modest. They catch less than 5% of the fish for five species, their catch is less than 10% for another 3 species and less than 25% for six additional species. Thus, these four entities have a significant role for quota ownership and the receiving of fish, but only a modest role for the actual catch of fish.

Table 5: Percentages of market held by the four largest LFRs and their affiliates.

Species	Quota Owned	Fish Caught	Fish Received
Shellfish			
CRA	14.2	0.0	1.4
OYU	13	20.7	0.0
PAU	29.2	0.0	17.4
Finfish			
BCO	22.5	0.3	27.1
BNS	38.7	16.6	55.5
ELE	40.7	4.4	83.4
FLA	28.9	0.7	56.7
GMU	9.8	0.0	51.0
GUR	43.8	9.3	66.0
HPB	34.5	8.2	52.1
JDO	41.6	16.6	74.1
RCO	45.8	20.1	73.6
SCH	31.8	10.5	60.7
SNA	46.3	24.5	72.1
SPO	33.2	4.2	58.8
STA	46.8	13.4	74.4
TAR	46.0	7.5	64.5
TRE	54.9	53.5	86.9

A graphical representation of concentration levels

Tables 2 through 4 have presented numerical measurements of concentration levels for quota owners, fishers and LFRs.

To represent all 18 of the species in the study by a single Lorenz Curve the species were combined using representative port prices to estimate their relative market value. Thus, market share for a given percentage of quota owners is measured by the estimated market value they own as a percentage of the estimated market value for all quota. Similar calculations were made for fisher's catch and fish received by LFRs. A selection of the data points is presented in

Table 6. The full resulting plots are shown in Figure 1.

Table 6: Selected data points plotted by the Lorenz Curves.

Percent of Smallest Owners/Fishers/LFRs	Percent Estimated Value of Quota	Catch Percent of Estimated Fish Value	Receive Percent of Estimated Fish Value
20	0.1	0.5	0.04
40	1.2	3.7	0.3
80	15.0	37.2	6.8
90	24.9	56.0	20.1
94	32.0	66.9	31.5
98	44.7	83.0	59.3
100	100.0	100.0	100.0

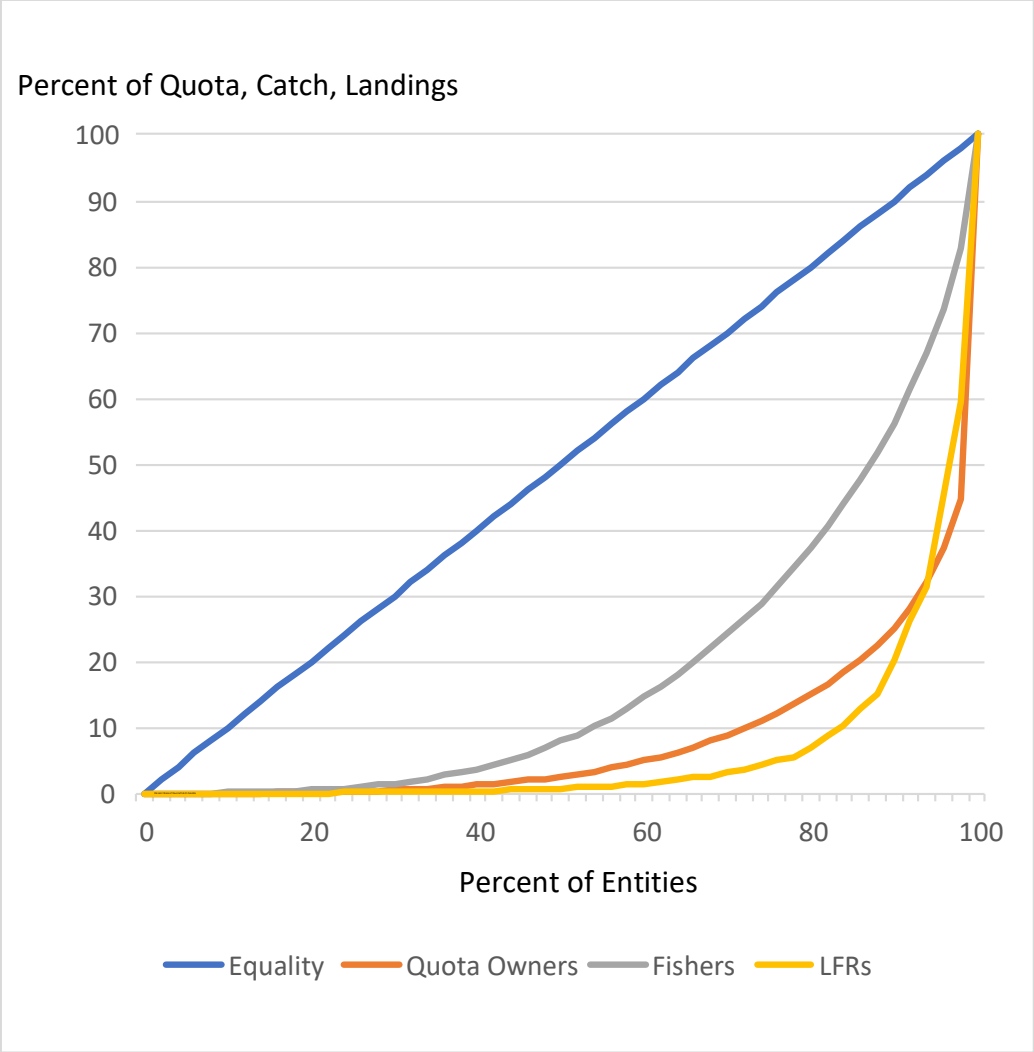

Figure 1 Lorenz Curves for Quota, Catch and LFR concentration.

The Lorenz Curves in Figure 1 provide visual confirmation that quota ownership in the inshore fishery is more concentrated than fishers' catch and that LFRs are generally more concentrated at all but the top extreme percentage of entities.

Discussion

The 15 inshore finfish species have an average of 193 active fishers. Thirteen of the species have a catch CR20 in excess of 54% and 10 species have a CR10 in excess of 50%. These results show that there are numerous smaller fishers co-existing with larger-scale fishers. Unlike the deepwater fishery, the results suggest that economies of scale are not a dominant force in the inshore fishery.

The middle depth and deepwater fleet are comprised of larger vessels, capable of coping with rougher seas and staying at sea for extended periods of time[f]. The presence of economies of scale drives rationalization, leading to fewer and larger vessels (Stewart and Callagher, 2011, Nielsen et al., 2021). The aggregation limits for deepwater fishstocks (45% for hoki and orange roughy, for example) also encourage scale, enabling fishers to accumulate a greater share of quota as a means of increasing catch. Consequently, quota concentration for commercially important deepwater species, such as hoki and orange roughy, exceed 80% at the CR4 level (Stewart and Callagher, 2011). This is considerably more concentrated than any of the inshore fisheries reported. Sanford, New Zealand's only publicly listed fishing company, reports that their fleet is comprised of 15 vessels (only 4 of which are inshore) in addition they report having 444

[f] See for example https://www.sanford.co.nz/operations/fishing/fleet/)

independent fishers who catch for them[g]. Other major seafood operators provide a similar breakdown for their inshore versus offshore fishing effort[h].

Although there is a presence of larger operators in the inshore fishery, the small fisher is still a significant force. Many of these fishers operate single vessels with 2 or 3 crew. It is evident that inshore fishers possess considerable fishing expertise. A fact that is acknowledged by the quota-owning LFRs who supply ACE to fishers in return for the catch landed to them. Some large LFRs who fish the middle-depth and deepwater fisheries choose not to fish the inshore fishery, instead relying on the fleet of inshore fishers to catch their ACE (Stewart and Moriarity, 2017). Many of these fisher-LFR relationships have endured for decades, perhaps because of the thin market for ACE leaving fishers with few options but also because of the mutual benefit derived from a stable business arrangement that neither partly wants to disrupt.

The levels of concentration for fish receiving are higher than for either catch or quota ownership (see Figure 1 and Table 5). The top 20 LFRs approach close to 100% of finfish received for a number of species. Looking at the four largest LFRs shows that while they own a sizeable proportion of the quota for most species (an average of 38% each for finfish) their share of the finfish catch is – with the exception of trevally – relatively low (12.6 % of catch each on average per species). This highlights their dependence on smaller fishers to catch for them. Their combined share of finfish species received is high; at an average of 63% each per finfish species. This presents a picture of an inshore fishery which has a small number of LFRs who rely on a relatively large number of fishers (many of small scale) to catch for them.

[g] https://www.sanford.co.nz/operations/fishing/fleet/
[h] https://www.talleys.co.nz/about-us

This picture suggests that a degree of specialisation has developed across the inshore fishery, with a measure of interdependence. The small ACE-reliant fishers need access to ACE to allow them to balance their catch, while the LFRs rely on the expertise of local fishers to do the work of harvesting. The LFRs in turn assist the small fishers by providing timely transfers of ACE to enable catch balancing (Stewart and Moriarity, 2017). LFRs and their independent fisher affiliates generally meet at the beginning of each fishing year to discuss catch plans that guide skippers in determining optimal catch portfolios, including which species to target and which bycatch to avoid due to the likelihood of ACE limitations (Stewart and Moriarity, 2017).

The ACE mechanism is pivotal in coordinating the LFR-fisher-quota owner functions. A key attribute of the ACE mechanism is the very low transaction cost for ACE transfers and the availability of information – all participants can see where unused ACE exists and can contact holders of unused ACE to pursue acquisition. Consequently, the New Zealand ITQ system, with its ACE regime, allows catch-balancing to work effectively, and facilitates the use of expert fishers to catch, while allowing LFRs to process and market fish, both locally and for export. Having an ITQ system with a low transaction-cost means of transferring catch shares (e.g., ACE) is seen as one of the main drivers of efficiency, see for example, Arnason, 1993; Herrmann, 1996; Kerr, 2004; Knapp, 1997; Grafton et al., 2000; Hartley and Fina, 2001; Newell et al., 2005; Grimm et al., 2012, Innes et al., 2014; Stewart and Leaver, 2016, Townsend and Walker, 2022.

The long-standing nature of LFR-fisher relationships creates an insider-outsider dichotomy; it is difficult for new entrants to access ACE for valuable target species and critical bycatch stock, ultimately restricting entry (Stewart and Lever, 2016). So, while the LFR needs the fisher's

expertise to land the fish, the LFR ultimately holds the ace-card; literally the holder of ACE dictates who will catch the fish.

An LFR with a substantial holding of ACE for a key bycatch fishstock holds considerable market power. They can influence who is able to fish for target species for which bycatch ACE is in short supply (for example, elephant fish in fisheries management area 3 (FMA3) Stewart and Moriarity, 2017).

In the absence of ACE, a fisher must pay a deemed value fee for fish landed without ACE. For many fishstocks, deemed value rates are progressive, increasing in line with levels of overfishing. In cases where a fisher has a high level of bycatch, for which they have no ACE, escalating deemed value fees may make a fisher's entire catch uneconomic (Walker and Townsend, 2008; Pascoe et al., 2010; Stewart and Lever, 2015 and 2016, Townsend and Walker, 2022).

An open market exists for ACE, where fishers can seek additional ACE, such as via quota brokers. However, ACE for problematic bycatch species, or valuable target species, is unlikely to be available in significant quantity and when it is available the price will be driven up due to excess demand (Stewart and Lever, 2015). The high price of quota and the constrained supply of ACE create barriers to entry, ultimately limiting the size of the inshore fleet. Small fishers also report that high compliance costs associated with the quota management system are a major factor contributing to decisions to exit from the fishery (Stewart et al., 2006 and Stewart and Walshe, 2008). This fact may contribute to the decision by some to participate as ACE-only fishers. It also

contributes to a low level of new entrants and conversely the tendency for fishers to pursue lifetime careers as fishers – a fact contributing to the expertise gained from many years of experience (Stewart et al., 2008).

Limitations and further research

The study considered 18 important inshore species using common measures of concentration at the species level. Accounting for associated entities provided an understanding of concentration from the point of view of effective control over quota and ACE for species under the QMS.

Further research is needed to examine concentration at the fishstock level. Most of the species studied have a number of separate fishstocks each with designated quota management areas (QMA), the quota and ACE of which are not transferable between QMAs. It is therefore possible for a single quota holder to have monopoly control over a particular fishstock and still not exceed the aggregation limit set for the species itself – effectively a spatial monopoly. Such a situation would give the entity (such as a quota-owning LFR) considerable market power over that fishstock's fishery. Since self employed fishers tend to fish in a single fisheries management area (FMA) the existence of a single source of ACE (monopoly) and single fish receiver (monopsony) gives considerable power to the LFR and little bargaining power to fishers who own no quota.

Conclusion

This study has examined 18 commercially important inshore finfish and shellfish species. Concentration levels for quota ownership are classified as 'unconcentrated'. The level of concentration for actual catch by fishers is also 'unconcentrated' for all species except trevally.

These levels of concentration are lower than those observed previously in the middle-depth and deepwater fisheries. However, licenced fish receiving for inshore species is noticeably more concentrated than for quota ownership and catch with five species being highly concentrated, five moderately concentrated, and seven unconcentrated. Highly concentrated markets for fish receiving, such as duopsony or oligopsony, where there are only two or a few buyers, limit the fishers' options for selling fish. If these buyers also control a large percentage of quota, they can also exert significant control over catch by limiting the sale of ACE to fishers who land to them. However, at this point, neither of these conditions seem to be at critical levels in the inshore fishery. Nevertheless, continued rivalry between LFRs is key to providing ACE-only fishers a fair return for fish landed.

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