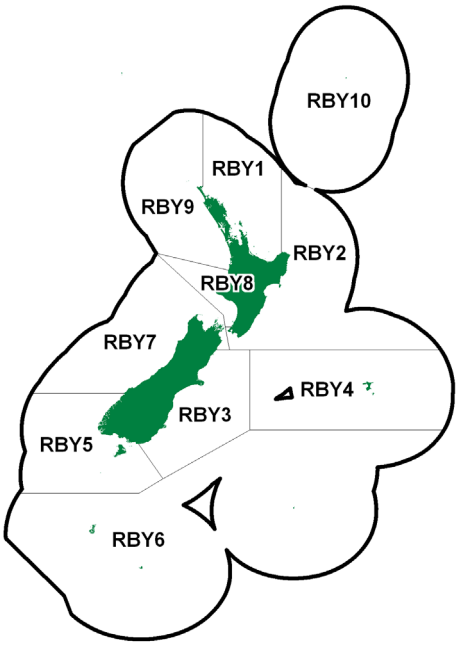
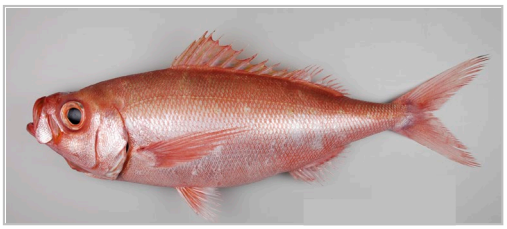
RUBYFISH (RBY)

(*Plagiogeneion rubiginosum*)





1. FISHERY SUMMARY

1.1 Commercial fisheries

Rubyfish catches were first reported in 1982–83. In 1990–91, 245 t were landed (Table 1), mainly as bycatch in the trawl fisheries for alfonsino, gemfish, barracouta, hoki, and jack mackerel. Landings doubled in the following year, and from 1992–93 to 1994–95 landings were about 600 t, taken mainly as bycatch of gemfish in the Bay of Plenty and from target midwater trawling in Statistical Areas 012 and 013 (RBY 2). In 1995–96, total landings increased to 735 t, before decreasing to 247 t by 1998–99. Since then landings have fluctuated between about 200 t and 750 t (Table 2).

The main rubyfish grounds (target species and alfonsino bycatch) are the banks or "hills" off the east coast of the North Island in RBY 2, and the Bay of Plenty (RBY 1). Although landings from RBY 1 increased from the mid-2000s, in most years landings have been greater in RBY 2 (which accounted for 70% of total landings during the 1990s), other than 2011–12 when RBY 1 accounted for 83% of landings. The level of direct targeting on rubyfish has increased over the history of the fishery, and most target catch is now taken from underwater features around East Cape and the Bay of Plenty.

Rubyfish are also taken as a bycatch of tarakihi tows (between 50 and 300 m bottom depth) from around all coasts of the North Island, Chatham Islands, and the upper part of the South Island. Bycatch of rubyfish in the hoki fishery is also widely distributed in deeper waters (200 to 450 m), including the Chatham Rise and the southeast coast of the South Island. Rubyfish have also been reported as an intermittent bycatch with barracouta, jack mackerel, bluenose, black cardinalfish, orange roughy, silver warehou, trevally, and scampi. Commercial concentrations of rubyfish probably also exist in areas that have not been fished in appropriate depths, especially in the northern half of New Zealand.

Rubyfish was introduced into the QMS on 1 October 1998. Initially allowances were not made for non-commercial catch. The historical landings and TACC values for the two main RBY stocks are shown in Figure 1.

RUBYFISH (RBY)

Table 1: Reported landings (t) of rubyfish by QMA and fishing year, 1983–84 to 1997–98. The data in this table has been updated from that published in previous Plenary Reports by using the data through 1996–97 in table 35 on p. 270 of the "Review of Sustainability Measures and Other Management Controls for the 1999–00 Fishing Year - Final Advice Paper" dated 6 August 1998.

	QMA 1	QMA 2	QMA 3	QMA 4	QMA 5	QMA 6	QMA 7	QMA 8	QMA 9	QMA 10	Other	Total
1990–91	66	159	5	3	0	0	9	0	3	0		245
1991–92	147	390	0	0	0	0	20	1	6	0		564
1992–93	90	491	0	0	0	0	31	0	0	0		612
1993–94	116	379	3	0	0	0	72	0	5	0		575
1994–95	43	500	3	12	0	0	13	0	10	0		581
1995–96	106	595	2	0	0	0	9	0	23	0		735
1996–97	128	297	2	1	< 1	0	14	< 1	21	< 1	1	463
1997–98	50	308	< 1	1	0	0	6	< 1	13	< 1	< 1	380

† QMS data.

Table 2: Reported landings (t) of rubyfish by Fishstock and TACCs from 1998–99 to present.**[Continued next page]**

Fishstock	RBY 1		RBY 2		RBY 3		RBY 4		RBY 5	
FMA	1		2		3		4		5	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1998–99	55	104	180	433	< 1	2	< 1	2	0	0
1999–00	138	104	321	433	6	2	< 1	2	0	0
2000–01	39	109	433	433	< 1	3	2	3	0	0
2001–02	36	109	414	433	1	3	8	3	1	0
2002–03	21	300	233	433	< 1	3	11	3	1	0
2003–04	19	300	343	433	< 1	3	2	3	< 1	0
2004–05	109	300	217	433	< 1	3	10	3	1	0
2005–06	135	300	303	433	< 1	3	33	3	0	0
2006–07	293	300	198	433	4	3	37	6	0	0
2007–08	120	300	427	433	< 1	3	11	6	< 1	0
2008–09	192	300	467	433	< 1	3	19	6	0	0
2009–10	351	300	309	433	2	3	11	6	< 1	0
2010–11	297	300	435	433	< 1	3	9	18	< 1	0
2011–12	278	300	73	433	< 1	3	4	18	< 1	0
2012–13	95	300	331	433	2	3	21	18	< 1	0
2013–14	223	300	349	433	< 1	3	15	18	< 1	0
2014–15	132	300	270	433	14	3	22	18	< 1	0
2015–16	145	300	286	433	30	30	19	18	< 1	0
2016–17	180	300	213	433	< 1	30	13	18	0	0
2017–18	71	300	104	433	< 1	30	17	18	1	0
2018–19	47	300	141	433	3	30	16	18	< 1	0
2019–20	302	300	207	433	< 1	30	59	18	< 1	0

Fishstock	RBY 6		RBY 7		RBY 8		RBY 9		RBY 10	
FMA	6		7		8		9		10	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1998–99	0	0	4	27	< 1	0	7	9	< 1	0
1999–00	0	0	13	27	< 1	0	15	9	0	0
2000–01	< 1	0	7	27	0	1	16	19	0	0
2001–02	0	0	35	27	< 1	1	3	19	0	0
2002–03	< 1	0	32	27	2	1	2	19	0	0
2003–04	< 1	0	9	27	8	1	1	19	0	0
2004–05	< 1	0	99	27	< 1	1	3	19	0	0
2005–06	< 1	0	8	27	8	1	20	19	0	0
2006–07	0	0	13	33	< 1	5	1	19	0	0
2007–08	< 1	0	4	33	1	6	1	19	0	0
2008–09	< 1	0	14	33	< 1	6	2	19	0	0
2009–10	0	0	4	33	< 1	6	< 1	19	0	0
2010–11	0	0	5	33	< 1	6	< 1	19	0	0
2011–12	0	0	18	33	< 1	6	<1	19	0	0
2012–13	< 1	0	2	33	< 1	6	1	19	0	0
2013–14	0	0	48	33	< 1	6	< 1	19	0	0
2014–15	< 1	0	4	33	< 1	6	1	19	0	0
2015–16	0	0	3	33	< 1	6	1	19	0	0
2016–17	0	0	9	33	< 1	6	< 1	19	0	0
2017–18	0	0	5	33	< 1	6	1	19	0	0
2018–19	< 1	0	16	33	< 1	6	2	19	0	0
2019–20	0	0	1	33	< 1	6	3	19	0	0

Table 2: [Continued]

	Total	
	Landings	**TACC**
1998–99	247	577
1999–00	493	577
2000–01	358	595
2001–02	498	595
2002–03	302	595
2003–04	382	595
2004–05	439	595
2005–06	507	786
2006–07	546	849
2007–08	564	800
2008–09	694	800
2009–10	677	800
2010–11	747	812
2011–12	374	812
2012–13	452	812
2013–14	635	812
2014–15	444	812
2015–16	482	839
2016–17	415	839
2017–18	198	839
2018–19	225	839
2019–20	573	839

In the 2002–03 fishing year, the TACC for RBY 1 was increased under the Adaptive Management Programme (AMP) to 300 t. At the same time a customary allowance of 1 t, a recreational allowance of 2 t, and an allowance of 15 t for fishing-related mortality took the TAC to 318 t. All AMP programmes ended on 30 September 2009. The RBY 1 TACC remains unchanged at 300 t, and with the exception of the fishing year 2009–10 landings have remained below the TACC (Table 2). In RBY 2 the TACC has remained unchanged at 433 t since 1998, with landings only slightly exceeding the TACC in 2008–09 and 2010–11. Landings in both areas were below average in 2017–18 and 2018–19, but increased in 2019–20.

The RBY 3 TACC was increased from 3 t to 30 t for the fishing year 2015–16 (when the TACC was met), but landings have been 3 t or less since 2016–17. RBY 4, 7, and 8 stocks landings were above the TACCs for a number of years, so the TACCs were increased to the average of the previous 7 years plus an additional 10% from the 1 October 2006; the TACCs for RBY 4, 7, and 8 were increased to 6, 33, and 5 t respectively. Landings continued to exceed the TACCs after 2006–07, resulting in a further TACC increase to 18 t for RBY 4 from 1 October 2010. An allowance of 1 t was allocated to RBY 4 at the same time, bringing the TAC to 19 t. A TACC of 19 t has been allocated to RBY 9 since the 2000–01 fishing year, but landings have fluctuated between <1 t and 2 t since 2007.

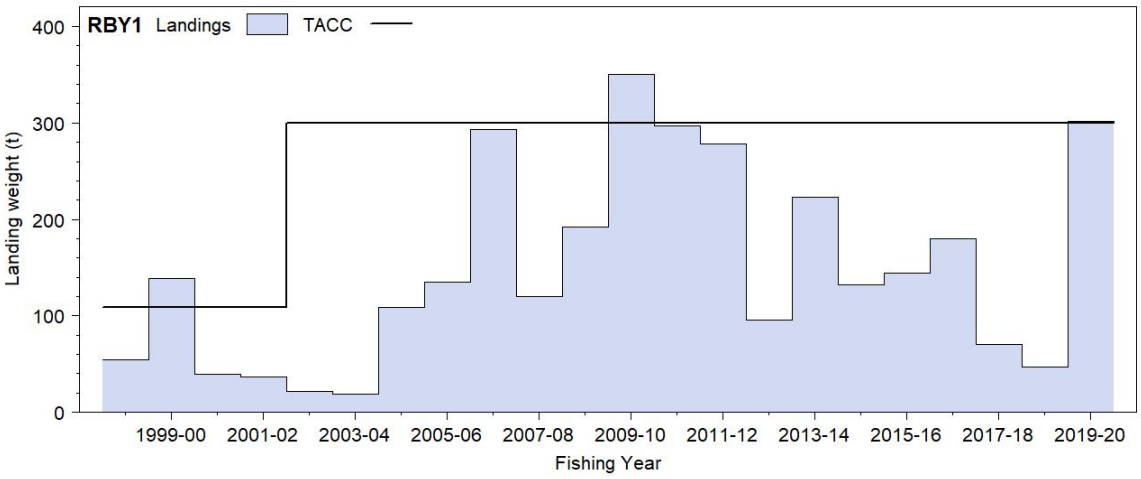


Figure 1: Reported commercial landings and TACC for the two main RBY stocks. RBY 1 (Auckland East) and RBY 2 (Central East). Note that these figures do not show data prior to entry into the QMS [Continued next page]

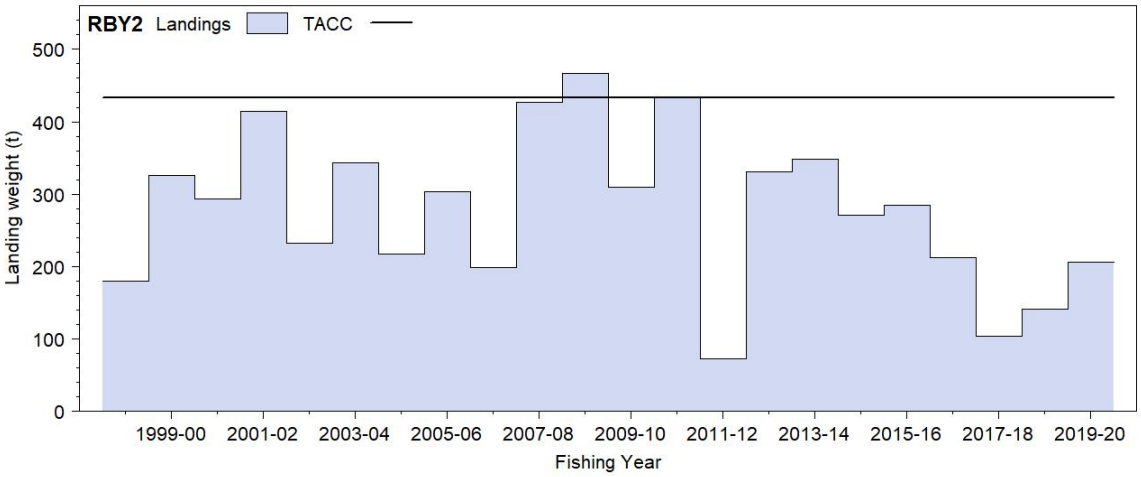


Figure 1 [Continued]: Reported commercial landings and TACC for the two main RBY stocks. RBY 1 (Auckland East) and RBY 2 (Central East). Note that these figures do not show data prior to entry into the QMS.

1.2 Recreational fisheries

There is no reported recreational catch.

1.3 Customary non-commercial fisheries

There is no quantitative information on the current level of customary non-commercial take.

1.4 Illegal catch

There is no quantitative information on the level of illegal catch.

1.5 Other sources of mortality

There is no quantitative information on the level of other sources of mortality.

2. BIOLOGY

Rubyfish are recorded from southern Australia, South Africa, and from banks in the southern Indian and south-east Atlantic oceans. They occur in the subtropical water around northern and central New Zealand, but are absent from the southern Chatham Rise and Campbell Plateau. Rubyfish occur at depths ranging from 50 m to at least 800 m. Most commercial catch is taken between 200 m and 400 m.

Rubyfish have been recorded up to 58 cm in length. Small catches of rubyfish in research tows have been of similar-sized fish, suggesting schooling by size.

Ageing research based on simple counts of otolith structures indicate that rubyfish are a slow-growing and long-lived species (Paul et al 2000). Paul et al (2003) and Horn et al (2012) used radiocarbon dating techniques on otoliths from 10 rubyfish to determine that the oldest fish in the sample were born prior to the beginning of the period of atmospheric testing and therefore were at least 45 years old. The ages they determined using an age-length-key derived from a catch sampling programme showed that although rubyfish could live to 100+ years, the commercial catch was dominated by young fish (8–15 years).

Horn et al (2012) analysed stable isotopes (oxygen and carbon) from rubyfish otoliths. They showed changes in mean depth with age, with rubyfish near the surface as juveniles, moving deeper with age, and adult rubyfish appearing to reside in 600–1000 m, with some apparent depth through the vertical water column (or possibly changes in geographic location) migrations within this range. They hypothesised that most rubyfish caught commercially are late juveniles and early adults in a transitional phase between early life in near surface semi-pelagic water and adult life in deeper water inaccessible to fishing. However, the suggestion by Bentley et al (2013) that rubyfish populations on distinct topographic features have been serially depleted is supportive of an alternative hypothesis that

the exploited fish are part of a transient population which move up sporadically from deeper water to these features for an unknown length of time, probably to feed, thereby becoming vulnerable to fishing operations.

There is little information on rubyfish spawning cycles or areas. Sparse observer records of female gonad stages suggest a November to February spawning season, but that is based on the percentage of fish that are mature. Actual observations of reproductive stage four and five fish during those months are rare, suggesting that they are largely unavailable to the commercial fishery.

Observations on gut contents show that rubyfish feed on midwater crustaceans, salps, and myctophid fishes. Stable oxygen isotope chemistry of samples taken from the core to the outer edge of the otoliths of large fish indicate that juvenile rubyfish feed on significantly lower trophic levels than the adults, but that their metabolic rates declines between age 5 and 10, and trophic level increases as they descend through the water column to depths of about 600 m (Horn et al 2012).

Horn et al (2012) further refined the growth estimates using a four parameter model fitted to the length-age data for ages 8 years and older, while constraining t_0 to be 0.5 (to remove the influence of the younger aged fish). The resulting unweighted length-at-age data were fitted using the von Bertalanffy growth model:

$$L_t = L\infty\,[1 - \exp(-K \times (t - t_0))]^P$$

Note that when P = 1 the growth model becomes the often-used three-parameter von Bertalanffy equation.

Biological parameter estimates are given in Table 3.

Table 3: Estimates of biological parameters for rubyfish.

Fishstock	Estimate				Source
1. Natural mortality (*M*)					
All	*M* = 0.03 – 0.1				Paul et al (2000, 2003)
2. Weight = a (length)^b (Weight in g, length in cm fork length)					
				Both sexes	
	a	b			
RBY 2	0.0255	2.9282			NIWA (unpub. data)
3. von Bertalanffy growth parameters					
				Both sexes	
	L_∞	K	t_0	P	
RBY 2	48.68	0.045	-16.53		Paul et al (2003)
	47.7	0.031	-0.5(constrained)	0.216	Horn et al (2012)

3. STOCKS AND AREAS

It is not known whether different regional stocks of rubyfish occur in New Zealand waters.

Although landings are reported by Fishstocks which align with the standard QMAs, for stock assessment purposes it may be more appropriate to consider Fishstocks RBY 1 and RBY 9 as one (northern) unit, Fishstock RBY 2 (the main fishery) as an eastern unit, Fishstocks RBY 3–5 as a minor southern unit, and Fishstocks RBY 7 and RBY 8 as a western unit.

4. STOCK ASSESSMENT

4.1 Estimates of fishery parameters and abundance

A biomass index derived from a standardised CPUE (log linear, kg/day) analysis of the target trawl fishery represented by 10 main vessels (Blackwell 2000) was calculated for RBY 2. However, the results were highly uncertain, mainly due to the limited amount of data available, and were not accepted by the Inshore Working Group.

Since 2000–01, most of the rubyfish catch has come from target trawling and since 2008–09, most has come from a single vessel. Furthermore, the target fishery is focused on, and has shifted effort between, relatively few underwater features. This provides the potential for aggregate catch per unit effort to mask localised depletion. For these reasons, QMA wide CPUE standardisations have not been attempted in recent analyses. Summaries of catch, effort, and unstandardised CPUE from the target midwater trawl fishery for eight separate groups of underwater features in RBY 1 and RBY 2 suggest serial depletion both between, and within, groups of features. Initially high catch rates at the southernmost features that were the earliest focus of targeting, declined sharply after only a few years of fishing, and both effort and catch subsequently shifted northward. There is evidence of ongoing "test" fishing on southern features, but catches and catch rates have remained low. In the more recently developed fisheries further north at East Cape and in the Bay of Plenty, catch rates appear to have been maintained by shifts in effort within each group prompted by the discovery of new features within them (Bentley et al 2013).

4.2 Biomass estimates

No information is available.

4.3 Estimation of Maximum Constant Yield (*MCY*)

MCY cannot be determined.

4.4 Estimation of Current Annual Yield (*CAY*)

CAY cannot be determined.

4.5 Other yield estimates and stock assessment results

No information is available.

4.6 Other factors

A substantial catch of rubyfish has been taken in conjunction with alfonsino by the trawl fishery off the North Island east coast. Future quotas and catch restraints imposed on rubyfish could, in turn, constrain the alfonsino fishery. Rubyfish is taken in smaller, irregular quantities in other target trawl fisheries and these fisheries could also be affected by future rubyfish management policy.

Catch sampling has occurred in RBY 2 for four years 1998–99 to 2000–01, and 2006–07 and 2007–08 though data for the recent years are of little value. It is likely that the age composition of RBY varies across features and as the exact location of the samples is not known it is unclear whether the samples have come from the areas that have been consistently fished over time. The earlier catch sampling data show that the fishery is comprised of a large number of age classes with a reasonable proportion of the catch coming from fish of greater than 50 years old (Horn & Sutton 2009).

5. ANALYSIS OF ADAPTIVE MANAGEMENT PROGRAMMES (AMP)

The Ministry of Fisheries revised the AMP framework in December 2000. The AMP framework is intended to apply to all proposals for a TAC or TACC increase, with the exception of fisheries for which there is a robust stock assessment. In March 2002, the first meeting of the new Adaptive Management Programme Working Group was held. Two changes to the AMP were adopted:

- a new checklist was implemented with more attention being made to the environmental impacts of any new proposal;
- the annual review process was replaced with an annual review of the monitoring requirements only. Full analysis of information is required a minimum of twice during the five year AMP.

RBY 1

The TACC for RBY 1 was increased from 109 t to 300 t under the Adaptive Management Programme (AMP) in October 2002.

Full-term Review of RBY 1 AMP in 2007

In 2007 the AMP FAWG reviewed the performance of the AMP (Starr et al 2007). The WG noted:

Fishery characterisation

- Fish are landed as green weight, so there are no conversion factor issues.
- Historical landings have been primarily taken as a bycatch of the bottom trawl fishery targeted at gemfish in the Bay of Plenty. These landings have nearly disappeared as a result of the decline in that fishery.
- The main target fishery has been a midwater trawl fishery associated with features in the Bay of Plenty which operated in 2004–05 and 2005–06.
- It was noted that there may be some merit in considering management options like feature limits in this fishery.

CPUE analysis

- There are insufficient data to use for a standardised analysis so four unstandardised analyses were presented, three from bycatch trawl fisheries for gemfish, tarakihi, and hoki, and one from a bycatch bottom longline fishery directed at hapuku and bluenose. No series was constructed from the target rubyfish fishery because there were sufficient data in only three years. The CPUE trends in the four bycatch fisheries showed variable trends which appeared to reflect effort trends in the respective fisheries rather than RBY biomass trends.

Logbook programme

- There are no logbook data in the database, except 1 trip and 4 tows. There is a problem in obtaining samples because it is difficult to sample the fish, because they are directly dumped into sea water tanks on the ship.
- Recommend a shed sampling programme, or a similar approach to obtain biological data, but the programme will endeavour to collect data that will allow the fish to be linked to a tow.

Environmental effects

- Catch has never exceeded the TACC over the term of the AMP. The target gemfish fishery, the primary bycatch fishery for this species, has diminished considerably in recent years.
- No code of practice in RBY fishery.

Conclusion

- If the AMP continues, there is a need to improve the collection of information. There is a need for more biological data, such as otoliths and lengths from every large landing of this species.
- There is also a need for improved fine-scale catch and effort information for smaller areas.
- The Working Group indicated that a catch curve analysis approach is likely to be the most effective way to monitor this Fishstock.

6. STATUS OF THE STOCKS

RBY 1

In 2002, RBY 1 was included in the AMP on the basis that the stock had been lightly fished and it seemed likely that the stock was above B_{MSY}. There has been an increase in targeted midwater trawling in RBY 1 and in the 2011–12 fishing most of the national catch was taken in this QMA. It is not known whether the level of recent commercial catches in this QMA is sustainable. The status of RBY 1 relative to B_{MSY} is unknown.

RBY 2

Catch sampling between 1998–99 and 2000–01 indicated that the fishery was then comprised of a large number of age classes with a reasonable proportion of the catch coming from fish of greater than 50 years old. Although relatively high catches were made prior to this period there was no obvious truncation of the age distribution to indicate high and unsustainable levels of fishing mortality. However, catch rates have since declined and there is evidence of serial depletion of underwater features. The catch age structure has not been adequately sampled since then.

Historically, most of the RBY catch came from RBY 2 but have since declined due to reductions in both gemfish and rubyfish targeted midwater trawling effort in the QMA. It is not known whether the level of recent commercial catches in this QMA is sustainable. The status of RBY 2 relative to B_{MSY} is unknown.

Other areas

For most other areas it is not known if recent catches are sustainable. Commercial concentrations of rubyfish probably also exist in areas that have not been fished. The status of other RBY stocks relative to B_{MSY} is unknown.

7. FOR FURTHER INFORMATION

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