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Fisheries accounts, a summary of current work in New Zealand and Australia

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FISHERIES ACCOUNTS, A SUMMARY OF CURRENT WORK IN NEW ZEALAND AND AUSTRALIA

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Summary

Fish accounts attempt to measure the size, use, value and sustainability of fish resources over time. The Handbook of National Accounting, Integrated Environmental and Economic Accounting for Fisheries (SEEAF) provides useful guidelines for development of fish accounts.

This paper reviews the accounting standards for fish stocks in the SNA and SEEA. The paper also explores opportunities for, and issues encountered in, compiling estimates for the value of fish stocks from both quota and catch entitlement data derived from the management of fisheries resources in New Zealand. Commercial fisheries in New Zealand are managed under a system of individual transferable quotas that covers 95 percent of the total commercial catch making them a useful model to examine the feasibility of this approach.

The paper then proposes a method, developed within the Australian Bureau of Statistics, for integrating the value of natural growth and harvest of wild- fish stocks to derive a measure of sustainability of income from using these stocks in production.

FISH ACCOUNTS

1. Introduction

a) Why compile fish accounts?

1. Fish accounts attempt to measure the size, use and value of fish resources over time. The term "fish accounts" is used broadly, and includes accounts for a wide range of living aquatic resources, both produced and non-produced.

2. Many of the world's wild-fish stocks are subject to high, frequently excessive, exploitation levels by commercial fishing activities, as well as being occasionally over-harvested by recreational fishers and subsistence fishers. The abundance and health of wild-fish stocks are also increasingly affected by pollution and habitat degradation. The dual impacts of excessive exploitation levels and habitat degradation result in the loss, or reduction, of the economic value of the goods and services provided by the aquatic ecosystems and a loss of biodiversity and genetic resources.[1]

3. While fish resources are renewable assets, they are also limited and are subject to over exploitation unless managed carefully. Fish accounts provide a framework for assessing the consequences of fishing activity to help inform fishers, fishery managers and policy makers of the economic and environmental costs and benefits of fishing and other activities that may impact on fish resources.

b) Scope of fish accounts

4. Non-produced fish stocks have several characteristics that make them difficult to measure reliably. Stock levels are generally not observable but are inferred from remote sensing, modelling and fish catch and effort records in any period. Individual fish stocks may include migratory species, straddling stocks, and fish that live permanently in the high seas, making them difficult to observe and monitor. In practice, it is generally only commercially targeted fish stocks with economic values where sufficient information is collected and available for compiling accounts.

5. Accounts may be compiled in either physical or monetary units, or a hybrid combination of both. Hybrid accounts are often used for fish accounting as the combination of physical and monetary information reflects the range of data collected by both fisheries management agencies and national statistical offices.

2. Standards for fish accounting

a) SNA93

6. "Fish" and "fish stocks" are terms intended to cover a wide range of aquatic species used in production, including finfish, molluscs, echinoderms and crustaceans. Other species, including marine mammals and chelonians may also be incorporated into the general meaning of "fisheries" in the *System*.

7. Fish resources in the SNA fall into two broad categories:

   a) non-financial produced assets/inventories (aquaculture), and
   b) non-financial, non-produced, tangible assets (wild-fish stocks)

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[1] SEEAF paragraph 8

Aquaculture

8. Cultivated aquatic resources (from the aquaculture industry) are treated as produced inventories (for harvest) and produced assets (for breeding) in the *System*. As such, the methods for valuing their output, incomes and stock levels are as for other produced inventories/assets in the SNA, though in practice information on aquaculture may be difficult to access and disaggregate in the national accounts.

Wild-fish stocks

9. The treatment of non-cultivated aquatic resources has been less certain in the *System.* SNA93 treats fish and fish stocks in the same way as other naturally occurring assets used in production. The *System's* accounts are compiled for institutional units or groups of units and can only refer to the value of assets that belong to the units in question. Only those naturally occurring fish stocks over which ownership rights have been established and are effectively enforced can therefore qualify as economic assets and be recorded in balance sheets.[2] As the 'ownership' of certain straddling or migratory fish stocks may not be able to be enforced, they are not counted as economic assets in the *System*. Such stocks may include fish that:

a) cross the Exclusive Economic Zone (EEZ) boundaries of one coastal state into that of an adjoining state;
b) are highly migratory and move between EEZ's and adjacent high seas;
c) are found both within the EEZ and adjacent high seas; and
d) are found exclusively in the high seas.

10. Secondly, to comply with the general definition of an economic asset, natural assets must not only be owned but be capable of bringing economic benefits to their owners, given the technology, scientific knowledge, economic infrastructure, available resources and set of relative prices prevailing on the dates to which the balance sheet relates.[3]

11. SNA93 thus delineates a restricted range of fish stocks for inclusion as assets in the *System*. These are:

- fish and other aquatic species produced through aquaculture, and
- fish stocks in territorial waters (including inland lakes and streams) that provide an economic benefit to their owners.

12. Effective ownership of fish stocks, other than aquaculture stocks, has generally fallen to government through their roles as managers of waters within their EEZ. That ownership of fish stocks within the EEZ provides an economic benefit to governments may be moot, however Governments' effective control of the resources contained within the EEZ is prima facie evidence that such resources are economic assets.

13. The fish stocks included within the SNA93 asset boundary may support a range of uses in production, including:

- commercial wild-fish catch,
- commercial aquaculture,
- ornamental fish collection,
- recreational fishing,

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[2] 1993 SNA 10.10
[3] 1993 SNA 10.11

- traditional/customary fishing,
- ‘ecotourism’.

14. While each of these uses has a value capable of measurement in the accounts, it is generally only the stocks and production associated with commercial wild-fish catch and aquaculture that are measured.

15. Draft SNA93 Rev1 has extended the asset boundary for fish stocks by allowing inclusion of fish stocks in the high seas that are subject to international agreement on how much can be caught by individual countries.[4] The 1995 Agreement on the Conservation and Management of Straddling Fish stocks implies that ownership of such stocks is established when an international agreement for their management has been agreed between the participating fishing nations such that sufficient control has been exercised to consider the stock an asset and attribute portions of the asset to member countries. Draft SNA93 Rev1 further notes though that only those resources that are currently or likely to be soon exploitable for economic purposes should be included.[5]

16. For Australia, the effect of the SNA93 Rev1 asset boundary extension will be to bring internationally managed fisheries for southern bluefin, bigeye and yellowfin tuna, swordfish, and additional orange roughy stocks into the asset boundary for Australia’s national balance sheet.

b) SEEA

17. SEEA takes a broader view of measuring fish than the SNA, as it does for other natural resources. It extends the SNA asset boundary to cover all environmental entities that are of interest and can be measured, in fact any entity that provides an environmental ‘function’. There is no requirement that assets must be ‘economic’, that they be owned, or that they provide a stream of benefits to their owners.

18. Environmental assets covered by SEEA are grouped into the following broad categories:

Natural resources
- Mineral and energy resources
- Soil resources
- Water resources
- Biological resources

Land and associated surface water
Ecosystems

19. Fish in SEEA are ‘aquatic resources’, a sub-set of the ‘biological resources’ category, though it can be argued that they also form part of ‘aquatic ecosystems’ a sub-set of the ‘ecosystems’ category. Aquatic resources also include a range of resources other than fish, such as sponges and seaweeds as well as aquatic mammals and chelonians.

20. SEEA further partitions aquatic resources into ‘cultivated’ and ‘non-cultivated’ resources, as follows:

Aquatic resources
- Cultivated

[4] SNA93 Rev.1 (draft) 19.158
[5] SNA93 Rev.1 (draft) 19.170

For harvest
For breeding
Non-cultivated

21. SEEA's cultivated/non-cultivated dichotomy thus coincides with the produced/non-produced asset split in the SNA.

22. Though SEEA's scope of fish includes anything that can be measured, in practice most interest (and research) is in fish and fish stocks that are commercially exploited. As such, SEEA and SNA accounts will tend to cover the same scope. A principal difference is that SEEA permits a range of physical and hybrid measurements in addition to the purely monetary measurements in the SNA. SEEA also allows costs of depletion and degradation of natural resources to be incorporated into the income accounts, permitting a range of adjusted measures of income. The SNA measures depletion and degradation in the *Other changes in volume of assets account*, rather than allowing income to be adjusted for these impacts of production.

3. Techniques for valuing fish stocks

23. Statistics New Zealand (SNZ) has produced two *Fish Monetary Stock Accounts* covering the period 1996-2003, later revised to cover the period 1996-2006. The accounts present time series of the total value for New Zealand's wild-stock commercial fish resource assets, as well as asset values for individual species.

24. The asset value of commercial fish resources is dominated by five major species: hoki, rock lobster, paua[6], arrow squid and orange roughy (which together contributed about 55% of total asset value in 2006). Table 1 shows the value of these species, plus that for all other species, at 30 September 1996 to 2006. The value of recreational fish stocks, fish stocks for customary use and fish stocks outside the Quota Management System are excluded from the series.

Table 1. New Zealand's Commercial Fish Resource, 1996–2006, (NZ$ million)

Species	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Hoki	642	556	398	580	512	973	700	815	695	541	627
Rock lobster	368	376	407	374	465	447	591	689	644	585	612
Paua	143	195	208	193	255	245	260	328	355	379	366
Arrow squid	167	140	76	136	132	81	52	103	240	138	298
Orange roughy	233	262	194	208	197	157	237	225	324	300	277
All other species	1188	1197	1002	1109	1081	1195	1346	1441	1607	1788	1646
Total	**2740**	**2726**	**2285**	**2600**	**2641**	**3097**	**3185**	**3601**	**3866**	**3730**	**3825**

a) Management of New Zealand's commercial fish stocks

25. New Zealand's commercial fisheries are managed under a Quota Management System[7] (QMS) instigated in 1986. As at 30 September 2006, 94 species, comprising 95 percent of the total commercial catch (by weight), were managed under QMS in 591 quota management areas. Within the QMS, a system of Individual Transferable

6 Paua or pāua is the Māori name given to a small group of monovalve molluscs endemic to New Zealand coastal waters. They belong to the family Haliotidae (genus Haliotis) of which there are approximately 130 species, usually known in the Northern Hemisphere as abalone.
7 It is not within the scope of this paper to provide a great deal of information on the Quota Management System. See Leslie and Lock (2007) for a history of the operation of the system. Sinner and Fenemor (2005) provide an appraisal of the system as a fisheries management tool.

Quota (ITQ) operates for each commercial fish stock. Commercial fishers own ITQ, which is a property right that can be bought and sold representing the shares they own in an individual fish stock.

26. New Zealand's commercial fish stocks are assessed using a programme of trawl or acoustic surveys for finfish and dive surveys for inshore species such as päua. The assessments, and the additional information provided by onboard observers employed by the Ministry of Fisheries and by commercial fishers through the completion of catch landing forms, are used both to determine the status of the stock and to ensure that the Total Allowable Commercial Catch (TACC) for that stock is set at a sustainable level. As it is not considered practical or cost-effective to assess all stocks, the most valuable and most vulnerable species are prioritised for assessment in any one year.

b) Quota and Annual Catch Entitlements (ACE)

27. Quota for fish stocks are expressed as shares that are whole numbers. The sum of that quota is always 100 million shares for each stock. The value of one share is equal to one hundred-millionth of the total quota shares for that fish stock. The annual catch entitlement (ACE) is the catching right generated each year from the share of the TACC that the quota holding represents.

28. Quota shares owned generate an ACE on the first day of the fishing year, which is expressed in kilograms. On allocation, the quota and ACE separate so the ACE can be traded independently of quota. Therefore, an operator that owns quota cannot fish for that quota unless they hold ACE; but an operator that holds ACE may fish for that stock regardless of whether they hold or own quota. All quota and ACE transfers must be registered with FishServe.[8] ACE can be transferred up to 15 days after the end of a fishing year, to allow catch to be 'balanced' up to the end of the fishing year.

29. Operation of the system is shown in the following example for a jack mackerel stock. Jack mackerel is managed under the quota code JMA in 3 fisheries management areas. JMA7 covers the stocks of the species on the west-coast of New Zealand extending from the far north to Awarua point in the West Coast region of the South Island.

JMA7 has 100 million quota shares.
▼
J Fisher owns 10,000 quota shares or 0.01 percent of the JMA7 fish stock.
▼
On 1 October, J Fisher's shares generate ACE.
▼
The TACC for JMA7 is set at 32,000 tonnes, therefore 1 share = 0.32kg.
▼
J Fisher's 10,000 quota shares generate 3,200kg of ACE.
▼
J Fisher can catch, or sell the right to harvest, 3.2 tonnes of JMA7 in that year.

30. Prior to 1 October 2001, the Fisheries Act 1983 allowed quota to be leased by the quota owner to another party for varying periods, determined by the parties to the transaction. After 1 October 2001, the Fisheries Act 1996 split the quota holdings into two property rights, ITQ and ACE. From that date, the ACE could be purchased by a

[8] FishServe is a company contracted by the Ministry of Fisheries to maintain a register of quota ownership

second party for the term of the fishing year. ACE can be on-sold multiple times before it is actually fished. For the period 1986 to 2000, there were an average of 9,300 lease transactions per year;[9] subsequently, the average number of ACE transfers per year has been around 60,000.

c) *Use of Quota/licence values in fisheries accounting*

31. Asset values in the *Fish Monetary Stock Account 1996-2003* were calculated using market prices of transactions in quota entitlements, which provide the right to the fish in perpetuity. This approach follows the SEEA guidelines, which note that an asset value for fish stocks can be calculated from the value of licences and quotas where realistic market values are available.[10] The asset value based on quota valuations methodology is equal to the average value of the traded quota ($/tonne) multiplied by the TACC. Because the valuations from this approach are market based and at the species level, movements in the series are easier to understand, interpret and relate to real world events, increasing the usefulness of the account for decision making.

32. There was brisk trade in quota immediately after introduction of the QMS, but as the fishing industry consolidated the number of quota trades declined. Between October 1986 and April 1988, there were 15,580 quota sales for 453,000 tonnes of quota.[11] In contrast the number of quota transfers recorded declined to fewer than 1,000 in 2002 and 2004. For many of the economically important species, quota trade value information was entirely absent. Had the quota valuation approach outlined above been repeated for the 1996–2006 update of the account, modelled values would have increased from less than 5 percent of total values (on average for the period 1996–2001) to over 50 percent of the total value in 2004.

33. The decline in quota trades lead to the adoption of a supplementary method for estimating the asset value of commercial fish stocks using the average value of ACE transfers to approximate the resource rent for the asset in that year. The net present value (NPV) method was then be used to discount the sum of the future net income stream (or rent) in order to express its present value. This approach requires additional assumptions to be made, including the choice of discount rate used.

34. In the absence of the QMS system and the associated values of quota and ACE transfers, it would be necessary to estimate the value of the capital services flows derived from the use of the natural resources – the resource rent. In theory this information can be derived from national accounts as follows: Assuming that information is available on the gross operating surplus and the net capital stock of the fishing industry, the Perpetual Inventory Method of valuing capital stock can be used to value consumption of fixed capital. Consumption of fixed capital is then deducted from gross operating surplus to derive net operating surplus. An estimate of the return to produced capital can then be deducted from net operating surplus, yielding an estimate of the resource rent.

35. The use of the NPV method to estimate market values is highly sensitive to assumptions about the discount rate and the rate of return to fixed capital, as well as

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9 Newell et al, 2005. Prior to October 2001, 'lease' would be an appropriate term as quota could be leased for a period determined by the two parties to the transaction. After this, quota holdings split into two property rights; it is the annual catch entitlement (ACE) that can be purchased by a second party for the term of the fishing year. When not referring to pre-2001 transactions, the terms 'ACE transactions' or 'transfers' is used.

10 2003 SEEA 7.272

11 Sissenwine and Mace (1992). In the year ending September 1988, 625, 875 tonnes of quota was managed under the QMS.

values for income and produced capital from the national accounts. The sensitivities in this method often provide volatile asset valuations that can be hard to interpret. Operating surplus estimates used in NPV calculations tend to be aggregated at a reasonably high level and any breakdowns into commodities or species need to be modelled. Where ACE transfers are used as an estimate of resource rent, the above issues and assumptions, with the exception of the choice of discount rate, are avoided.

36. The value of the quota represents the NPV of the owner's expected income from using the quota over its period of validity. If the fishery is managed with such quotas and the quotas are valid in perpetuity, the market value of all quotas should be equal to the value of the use of the fish stock. If the quotas are valid for a single year only, the total quota values should give an approximate resource rent in that year.[12] Where quota trade data are available, the quota valuation method is used as a first choice to value stocks. Where quota trade data is not available, the NPV method using ACE values is used in preference to modelled stock values.

37. The NPV method discounts the sum of the future net income stream (or rent) in order to express its value at the present time. The general formula for calculating the asset value of a resource is:

$$V_0 = \sum_{t=0}^{T_0} \frac{p_t Q_t}{(1+r)t}$$

$$p_t = \frac{R_t}{Q_t}$$

$$T_0 = \frac{S_0}{Q_0}$$

where

V_t value of the asset at time t
p_t unit rent price of fish at time t
Q_t quantity of fish catch during time t
r the discount rate
R_t total resource rent at time t
T_0 the remaining lifespan of the resource computed at time 0
S_t volume of stock at the end of the accounting period t.

38. The SNZ account assumes that fish stocks have stabilized at current levels under QMS management and that the current rent will continue into the future. Although these assumptions may vary for individual fish stocks on a year-to-year basis, they are implicit as sustainable use of the fisheries resource is a major objective of the QMS. In the case of a renewable resource like fisheries, which is being harvested at a constant, sustainable rate, the lifetime is infinite and the formula reduces to resource rent divided by the discount rate, i.e.:

$$V_t = \frac{p_t Q_t}{r}$$

39. Table 2 below, provides an example of asset value calculation for Hoki. Unlike many other species managed under the QMS, Hoki is managed in one quota

12 2003 SEEA 7.273

management area. For the years 1996–2003 and 2006 quota transfer information is available and is used, with the TACC, to estimate the species asset value. Where quota transfer information is not available the value of ACE transfers are used to approximate resource rent for the asset. The ACE values are discounted to express the asset value of the Hoki fishery at the present time.

Table 2. Asset valuation for Hoki

Species	Quota management area	Year	Quota transfer value per tonne (NZ$)	ACE transfer value per tonne (NZ$)	Discount rate	TACC	Valuation derived from discounted ACE values (NZ$ millions)	Source of final valuation figures	Final valuation (NZ$ millions)
Hoki	HOK1	1996	2674	..		240000		quota values	642
Hoki	HOK1	1997	2224	..		250000		quota values	556
Hoki	HOK1	1998	1590	..		250000		quota values	398
Hoki	HOK1	1999	2321	..		250000		quota values	580
Hoki	HOK1	2000	2047	..		250000		quota values	512
Hoki	HOK1	2001	3891	..		250000		quota values	973
Hoki	HOK1	2002	3499	331	0.09	200000	735	quota values	700
Hoki	HOK1	2003	4076	337	0.09	200000	749	quota values	815
Hoki	HOK1	2004	..	348	0.09	180000	695	ACE values	695
Hoki	HOK1	2005	..	487	0.09	100000	541	ACE values	541
Hoki	HOK1	2006	6268	525	0.09	100000	583	quota values	627

Symbol:
.. not available

d) Choice of discount rate

40. A discount rate is a time preference for money, reflecting the fact that income received in the future is not as valuable as income received today. Discounting is reflected in observed behaviour in that producers will prefer to invest where the productivity of capital is positive. By discounting future income so that it is comparable with income earned today, an asset's value, based on future income, can be estimated. The choice of the discount to be used in estimating an asset's value is a pivotal variable and is often the subject of considerable debate.[13]

41. The draft SEEAF lists discount rates used by five countries in preparing their fisheries asset values. The rates varied from a low of 3.5 percent in Norway to a high of 10 percent in Namibia.[14] SNZ's *Fish Monetary Stock Account 1996–2006* uses a discount rate of 9 percent. This rate was chosen as it is consistent with the return on similar assets in the New Zealand economy over the period measured. The use of a social discount rate was not considered as the fisheries resource assets in New Zealand are freely traded and owned entirely by private individuals and organisations.[15]

42. The fact that both quota and ACE values were available for some fish stocks over the period 2002–2006 meant that calculation of an implicit rather than an exogenous discount rate could be considered. Kerr et al (2003) examined the

13 2003 SEEA 7.188

14 2004 SEEAF 202

15 All new quota is auctioned to the highest bidder, individuals holding existing quota are free to sell it as they wish although there are some restrictions on minimum and maximum holdings see Lock and Leslie (2007) section 3.5.

relationship between Quota and lease values[16] and found that the implicit rate inferred by the relationship between quota and lease prices was broadly consistent with the rate of real interest rates over the period.

43. Some consideration was given to an approach where different fish stocks would have different discount rates applied to the calculation of asset value. This approach follows the argument that different operators have different costs of capital in extracting the asset from the environment. However, ACE may be transferred at any time and up to 15 days after the end of the fishing year as part of the catch-balancing process. It is therefore considered likely that individuals and organisations have considered their costs and risks and to have factored these into their bids when purchasing ACE. Furthermore it became apparent that having different discount rates for different species or groups of species implied that either asset growth rates, volatility or future stock levels varied across species, hence voiding the assumption that stocks have stabilised and observed prices will continue into the future.

e) Data limitations

44. Information on quota and ACE transfers, including prices paid, is registered with FishServe. SNZ in turn collects data on quota and ACE transfers from FishServe to prepare its values of fish stocks. There are some limitations to the data used for preparing fish stock value estimates, including:

a) Trading of individual quota is low, or non-existent, in some years.
b) Trades (quota and ACE) for nominal amounts, possibly between economically related parties, are not uncommon. These are removed from the data set prior to estimation.
c) Some ACE values (2 percent over the period 2002–2006) were unreasonably high and removed from the data set as they would have resulted in severe distortions to both the asset values and series trends in the account. It is likely that these trades included other assets, or were for periods of more than one year.

45. Even after removing outliers, there is still some price variability (particularly ACE transfer prices) that is difficult to explain. For example, in contrast to other species the number of trades for päua quota has not markedly declined since October 2001, when the ACE was created. This allowed the asset value for paua to be based mainly on quota trades rather than ACE transfers. Analysis of both quota trade and ACE prices for päua revealed that the ACE values may not be a true approximation of resource rent. A possible explanation for this result may be that ACE transactions in the paua fishery are priced to include factors such as the ACE purchaser agreeing to supply the paua directly back to the quota holder without any further monetary transaction taking place.

4. Utilising measures of production in the commercial wild-fishing industry for fish accounts

46. The value of production (gross value added) of the fishing industry, like most other industries, is obtained by subtracting the value of intermediate inputs from the value of gross output of the industry. Gross value added may also be derived as the sum of compensation of employees, gross operating surplus and net indirect taxes.

16 Kerr et al (2003) examine the data over the period 1986–1999, i.e. before the establishment of ACE.

47. Wild-fish stocks, like other assets used in production, provide capital services to the economy as they are used and are remunerated in the gross operating surpluses generated by the units that use them. For any enterprise or industry, its gross operating surplus can be decomposed into consumption of fixed capital and net operating surplus. For institutional units or industries using only produced assets as capital inputs, the whole of its net operating surplus is a return to the produced assets employed. For institutional units or industries such as the fishing industry that use a mixture of produced and non-produced assets (natural resources) as capital inputs to the production process, their net operating surplus can be further decomposed into returns to produced assets and resource rent.

48. Resource rent represents the value of capital service flows rendered by natural resources, or their share in gross operating surplus. Resource rents are not directly observable but instead are typically derived in what is termed the 'residual approach' as the difference between total revenue generated from the extraction of natural resources less costs incurred during the extraction process including the cost of produced capital (which itself includes a return to produced capital). Where vertical integration occurs between industries engaged in utilising the resource, financial information provided by enterprises may cover several industries and a true estimate of resource rent may not be obtainable through the residual approach.

49. The fishing industry is defined in the Australian and New Zealand Standard Industrial Classifications[17] as those enterprises whose activities mainly involve catching and gathering of marine life, and aquaculture. Fish processing is included in the food, beverage and tobacco manufacturing activity, within the manufacturing industry. However, where units mainly engaged in operating vessels, catch and process fish onboard the vessel, this activity is included as output of the fishing industry.

51. The SEEAF notes that much of the separation between fishing operations and fish processing is somewhat arbitrary, as integration occurs due to both the technology employed, where factory trawlers process and pack onboard, and the legal and institutional arrangements of the companies involved.[18] There are high levels of vertical integration between firms engaged in fishing and fish processing in New Zealand. For example, in the early stages of the QMS deepwater fisheries operators needed to prove that they had both the ability to access the fishery and the processing investment necessary to process the catch before being allocated quota (Lock and Leslie, 2007).

52. Where vertical integration occurs between industries engaged in utilising the resource, there may be difficulties in estimating the resource rent. The SEEAF suggests that in this case the residual method for estimating resource rent should be applied to both fishing and fish processing activities.[19] The asset value of wild-fisheries can be estimated using the market value approach outlined in section 3 above, or the residual approach for estimating the resource rent (discounted to express the asset value of the fishery at the present time). Both estimates should give similar results however the later method is very sensitive to a) identification of the scope of

[17] Australian and New Zealand Standard Industrial Classification (New Zealand Use Version) 1996 Version 4.1 2. A six digit classification system that is aligned with the International Standard Industrial Classification of All Economic Activities (ISIC), Revision 3.

[18] 2004 SEEAF 188

[19] 2004 SEEAF 189

assets of the industry b) choice of rate of return to those assets, and c) the choice of discount rate. Care also needs to be taken to separate the volumes of fish product that are imported for the purpose of processing.

53. ***Valuing production of aquaculture***

Measuring the output of aquaculture is complicated by the process of production extending over several months or even years. Aquaculture fish stocks are treated as works in progress, or output that is not yet ready to be sold, until they are removed from their environment. Once the fish are removed from their environment they are ready for sale or other use. Output should be recorded as being produced continuously over the entire period of production and not simply at the moment of time when the process is completed, i.e., when the fish are harvested.[20] Conceptually, output of aquaculture can be measured in the same way as for other types of production that take a long time to complete, i.e., by the value of sales plus other uses plus changes in inventories including additions to work-in-progress. As aquaculture utilises produced assets and inventories, no resource rent is identified in the operating surplus of the producing units.

5. Valuing depletion of fish stocks

54. It was noted earlier that resource rent represents the value of capital service flows rendered by natural resources, or their share in gross operating surplus. When natural resources are being used sustainably, all resource rent is a return (income) to the owner of the natural asset being used in production. However, natural resources are often used unsustainably in production, in which case the resource rent can be further decomposed into income to the owner of the non-produced assets and a measure of depletion. Depletion of non-renewable resources represents the reduction in the value of the asset as a result of the removal and using up of the asset. SEEA recommends that depletion be offset against income of units using non-renewable natural resources in production, such as the mining industry, while SNA records depletion as an economic disappearance in the *Other changes in volume of assets account.*

55. Wild-fish stocks used in production are economic renewable natural resources. The unique feature of renewable natural resources is that, under favourable conditions, they are able to sustain or increase their abundance through natural growth in excess of natural mortality. If fish stocks are used sustainably, they have infinite asset lives, although of course, individual fish have finite asset lives. It is perhaps because renewable natural resources have the ability to increase through natural growth that a charge for depletion of such assets is generally not made in accounting for the industries that use them.

56. SEEA aims to account for effects of economic activity on natural resource endowments to facilitate planning for sustainable development. An informed assessment of the sustainability of economic activity needs to consider natural growth of fish stocks used in production as well as the extraction of the fish. Thus, a more meaningful SEEA measure of sustainability of income from using fish stocks in production may be to integrate values for natural growth (net of natural mortality) and

[20] 1993 SNA 6.95

harvest, which together indicate if depletion of the resource is occurring, into an ‘adjusted’ measure of resource rent.

57. This approach leads to three alternative outcomes for valuing resource rent from harvesting wild-fish stocks in an accounting period:

1. Adjusted resource rent is entirely attributed to income;
2. Adjusted resource rent is split between income and depletion; and
3. Adjusted resource rent is entirely attributed to depletion.

58. Conventionally, natural growth of fish stocks is recorded as an economic appearance in the SNA *Other changes in volume of assets account* and an addition to stock levels from natural growth in a SEEA asset account (SEEA Table 7.5, A SEEA asset account). However, the conventional approach fails to indicate whether income derived from using fish stocks in production is sustainable in the long term.

59. Using SNA accounts as a template, it is now proposed that the value of net natural growth of fish stocks be recorded as an ‘other non-market output’ in the *Production account*, and the value of harvest be recorded as ‘consumption of natural capital’, a charge against this output. Domestic product will in turn change to reflect any excess of growth over harvest, or any excess of harvest over growth. Operating surplus and saving will similarly change to reflect the excess position. The value of the net growth is recorded as an ‘addition to the value of non-produced, non-financial assets’ in the *Capital account* while the value of harvest is recorded as a consumption of natural capital. ‘Net lending’ will be unaffected by the changed treatment. The *Changes in balance sheet* will record any excess in ‘tangible non-produced assets’, leading to a corresponding change in the *Closing balance sheet.* SEEA accounts would show corresponding adjustments. Together, these changes will provide a guide to the sustainable use of wild-fish stocks in production

60. Other events impacting on volumes of stocks, e.g. changes in volumes due to changes in classification or technology, changes due to degradation, or changes due to catastrophic events, etc., are still regarded as ‘other changes in volumes of the asset’, not depletion. Effects of price changes are not regarded as depletion; they are recorded in the *Revaluation account*.

61. The ‘adjusted’ approach outlined has the advantage of integrating both values of additions to stocks and harvest into an income stream measure that better indicates whether natural resources are being used sustainably (i.e., where growth equals or exceeds harvest) or unsustainably (where harvest exceeds growth).

References

Australian Bureau of Statistics (ABS), *Australian System of National Accounts: Concepts, Sources and Methods 2000*, Cat no. 5216.0

Australian Government, Bureau of Rural Sciences: *Fishery Status Reports 2006*, (Larcombe, J, McLoughlin, K, eds.) Department of Agriculture, Fisheries and Forestry

Bain, D., *Issues Paper: Depletion of renewable environmental resources*, for London Group Meeting, Rome, 17-19 December 2007

Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, World Bank, *System of National Accounts 1993*, Brussels/Luxembourg, New York, Paris, Washington D.C., 1993

Kerr, S., Newell, R. G., and J. N. Sanchirico (2003). *Evaluating the New Zealand individual transferable quota market for fisheries management,* http://www.motu.org.nz/nz_fish.htm [11/07/06].

Lock, L. and Leslie S. (2007). *New Zealand's quota management system: a history of the first 20 years*, Motu working paper 07-02, http://www.motu.org.nz/motu_wp_2007_02.htm [11/10/07]

Newell R G, Papps K L and Sanchirico J N (2005). *Asset Pricing in Created Markets for Fishing Quota,* http://www.motu.org.nz/nz_fish.htm [11/07/06].

Sinner, J., Fenemor, A. (2005). *The Adoption of ITQ for New Zealand's Inshore Fisheries.* Ecologic Research Report No. 4, November 2005

Sissenwine, M. P., Mace, P. M. (1992). *ITQs in New Zealand: The era of fixed quota in perpetuity.* Fisheries Bulletin 90: 147–160

United Nations, Food and Agricultural Organisation of the United Nations, *Integrated Environmental and Economic Accounting for Fisheries,* (Draft) 2004

United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, World Bank, *Integrated Environmental and Economic Accounting 2003*, Brussels/Luxembourg, New York, Paris, Washington D.C., 2003

United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, World Bank, Inter Secretariat Working Group, *Draft SNA93 Revision 1*