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Issue #12: Valuation of Assets: A case study on the valuation of fish stocks[1]

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[1] This outcome paper has been prepared by the SEEA Editor. It is based on papers presented to the London Group of Experts on Environmental Accounting and discussions among those experts. Investigation and research for this outcome paper was led by Jane Harkness, Luke Aki and Jeff Cope of Statistics New Zealand.

A. Introduction

1. Monetary valuation of natural resources is important in order to gain a broader understanding of the interactions between economic activity and the management and use of these resources. The importance of valuation is recognised in the System of Environmental and Economic Accounts (SEEA) and the valuation of natural resources has been undertaken by a number of national statistical offices.

2. The valuation of natural resources is not straightforward however since, unlike most produced assets, there are generally few sales of unextracted or unharvested natural resources. Therefore, in general, estimates of the value of natural resources must be based on valuation models.

3. The model that is recommended for use in the 2008 System of National Accounts (2008 SNA) and in the SEEA-2003 is the Net Present Value model, or NPV. This model takes estimates of the future income flows from the natural resource and discounts them using a discount rate to adjust for the fact that income earned in the future is worth less than income earned in the current period. Implicitly this reflects the assumption that the whole of the natural resource cannot be extracted at one time.

4. While there is a substantial discussion behind the choice of discount rates many of the measurement issues in applying NPV in practice concern the calculation of future income flows. Issues include dealing with volatile and potentially negative income flows, determining future rates of extraction and adjusting for growth of renewable resources.

5. The income flow from natural resources is generally termed resource rent and is equal to the sales of the natural resource by the extractor less the costs involved in undertaking the extraction including the full costs of any produced capital that is used. Thus in addition to the measurement issues just noted, there are also questions as to exactly how to measure the costs that need to be deducted in estimating the resource rent.

6. General advice is available on all of these and other measurement issues, including in the SEEA-2003 and in the 2008 SNA. This advice will be updated and expanded in the revised SEEA.

7. In discussing this issue within the London Group some specific work that had been undertaken in New Zealand (NZ) on the valuation of their fish stocks became an interesting focus. In New Zealand a market has been created around quotas for harvesting fish and this has allowed the development of methods to value the fish stock using observed market prices.

8. In particular what has been possible is to compare direct estimates of the resource rent that are derived based on market transactions to the indirect, or residual estimates of resource rent that are normally used in NPV models. The extensive work in this area by Statistics New Zealand is presented in this paper. The findings highlight that the specific advice provided in the SEEA-2003 on the valuation of fish stocks using quota based information is sound but also that the derivation of resource rent via residual methods must be applied with caution.

9. Another conclusion is that there is no reason to reject the use of NPV models. The work by Statistics New Zealand finds that the application of NPV models is appropriate provided that the estimates of resource rent are robust. In this regard the paper highlights many factors that might be considered to determine the quality of a resource rent estimate.

10. The paper is structured to introduce and describe the work on the valuation of New Zealand's fish stocks, to present the findings from this work concerning the estimation of resource rent, to discuss some finding regarding the measurement of discount rates and to present some overall conclusions for the SEEA revision. One recommendation is made in relation to the valuation of fish stocks. For more detail on the work by Statistics New Zealand readers are encouraged to consider the range of material presented in the list of references.

B. New Zealand's Quota Management System

11. In New Zealand, a Quota Management System (QMS) was introduced on 1 October 1986 with the passing of the Fisheries Amendment Act. While there have been numerous amendments to the act subsequently, the essence of the scheme remains the same. Within the QMS, a system of Individual Transferable Share 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.

12. Quota was initially allocated to the industry on the basis of catch history[2] and was valid in perpetuity. At the time quota was defined as a right to harvest a fixed tonnage of a particular species in a specific Quota Management Area (QMA). The actual tonnages were set annually as Total Allowable Commercial Catch (TACC) based on advice from various parties, the intent being to set a sustainable catch limit. As annual changes in the TACC required the government to issue or buy back quota tonnage – a complex and expensive process – the system was altered in 1990, to a share allocation system with only partial compensation to the quota owners. The ITQs now represented a percentage share of the TACC.

13. Quota is freely transferable, can be leased for varying periods and the quota owner can subdivide the quota for sale or lease as required. There are further restrictions on quota holdings such as those designed to ensure that only New Zealanders or New Zealand owned companies are able to purchase quota, and there are restrictions on maximum and minimum holdings in quota which differ from species to species.

14. In 2001 the system was further altered with the introduction of Annual Catch Entitlements (ACE) which created a clear separation between the permanent ownership of the harvest right and the right to harvest a specific amount in a given year. Under the new system, at the commencement of each fishing year, TACC for each species in each quota management area are declared, the quota holder's share is determined and an ACE is issued, the ACE being the right to harvest the current year's entitlement. ACE is freely transferable and the same ownership restrictions for quota equally apply. While you can hold ACE without holding quota, you cannot fish without ACE. In effect, the ACE has become a convenient way in which to lease quota.

15. Provided there are sellers, ACE can be purchased throughout the fishing year: prior to, during or after the harvest period. Actual harvest must be balanced each month against sufficient ACE, which can be purchased after the event (within limits) in order to comply with the law.

16. This change has led to a reduction in the number of quota trades while the number ACE transfers (essentially a 1 year lease) have increased steadily.

C. Valuing commercial fish stock using market information

17. Where fishing quotas are freely brought and sold in a well functioning market – as is the case in New Zealand – then, following the SEEA-2003:

> "The value of quota represents the NPV of the owner's expected income using the quota over its period of validity. If the fishery is managed with such quotas and the quotas are valid in perpetuity, the value of all quotas, at the market price, should be

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[2] Recent changes made by Parliament mean that quota in all species introduced into the QMS from 1 October 2004, other than some limited exceptions, will be subject to a tender process. No quota will be allocated on the basis of catch taken by a fisher.

http://www.fish.govt.nz/en-nz/Commercial/Quota+Management+System/introduction+of+species+into+qms.htm

equal to the value of the use of the fish stock. If the quotas are valid for a single year only, the total should give an approximation to the resource rent in that year." (SEEA-2003, paragraph 7.273)

18. As the ITQ are valid in perpetuity, the asset value based on quota valuations is equal to the average value of the traded quota ($/tonne) multiplied by the TACC.

19. This simple and straightforward valuation method had to be modified post 2001. Since the introduction of ACE for the 2001/02 fishing year the number of quota trades recorded for many of the important species has declined and a supplementary method based on ACE transactions has been adopted in cases where quota transfer information is not available for some species in certain quota management areas.

20. In these cases the annual resource rent for the species and area concerned is estimated as the average $/tonne (from the ACE transaction data) multiplied by the TACC. As the fisheries are managed on a sustainable basis, this resource rent is assumed to hold for all future years and the asset value for the species is set equal to the NPV of the future resource rents.

21. Based on the use of ITQ share market prices and ACE transactions for valuing fish stocks Statistics New Zealand has produced a *Fish Monetary Stock Account 1996-2007*, and the main results are shown below.

Table 1

New Zealand's Commercial Fish Resource, 1996-2007[1]

(NZ$000)

Year ended September

species	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Hoki	642	556	398	580	512	973	700	815	695	541	627	693
Rock lobster	368	376	407	374	465	447	591	689	644	585	612	621
Paua	143	195	208	193	255	245	260	328	355	379	366	390
Snapper	289	272	191	185	197	249	282	298	282	258	226	252
Orange Roughy	233	262	194	208	197	157	237	225	324	300	277	250
Ling	143	162	153	185	141	155	201	172	196	219	197	231
Arrow Squid	167	140	76	136	132	81	52	103	240	138	298	170
Hake	110	102	100	112	109	106	108	141	147	123	188	141
Scampi[2]	..	..	..	..	..	..	..	..	..	116	125	117
Oreos	80	86	59	71	65	64	60	59	68	68	72	85
All other species	566	575	499	556	569	621	696	770	914	1,004	849	868
Total	**2,740**	**2,726**	**2,285**	**2,599**	**2,641**	**3,097**	**3,185**	**3,601**	**3,866**	**3,730**	**3,836**	**3,819**

1 As estimated in the *Fish Monetary Stock Account 1996–2007* using ITQ values

2 Scampi was introduced into the QMS on 1 October 2003

D. A residual value approach for valuing commercial fish

22. When asset markets do not exist, an alternative valuation option is to estimate the Net Present Value of the implied resource rents accruing from holding or using the asset, where the resource rent is estimated redisually using data on sales income and input costs. This approach is labelled here as the residual value approach.

23. In applying this approach for NZ fish stocks some of the same assumptions are applied as those made when using the ACE payments as an estimate of the resource rent, viz. that fish stocks have stabilised and are being harvested at a sustainable rate, and the resource rent is fixed for all future years. The residual value method discounts the sum of the future constant net income stream (or resource rent) in order to express its value at the present time. As with the ACE component of the market valuation method, a discount rate of 9 percent is used.

24. In order to apply the residual value approach, it is necessary to first calculate the implied resource rent of the natural resource. The derivation of the resource rent is based on a partitioning of the economic rent accruing to the extractor based on the use of all assets (both produced assets and natural resources (i.e. the gross operating surplus). The economic rent can be split into that part relevant to produced assets and that part relevant to non-produced assets including natural resources. In this study, the only non-produced asset earning resource rent is assumed to be the fish stock.

25. This partitioning is set out in the SEEA-Fisheries as[3]:

$$R = TR - (IC+CoE+CFC+NIT+NP)$$

$$NP = i * K$$

where: R = Resource rent, TR = Total revenue, IC = Intermediate consumption, CoE = Compensation of employees, CFC = Consumption of fixed capital, NIT = Net taxes on production, NP = Normal profit/Return to fixed capital, i = Rate of return to fixed capital, K = Value of fixed capital

26. With the exception of the return to fixed capital all of the variables are available from the national accounts. The return to fixed capital can be calculated by applying a normal real rate of return to the net stock of fixed capital in the fishing industry. For this exercise an 8 percent real rate of return to fixed capital was used which is consistent with Statistics New Zealand's mineral accounts and with international practice.

27. It is recognised that the use of the residual value approach can be sensitive to assumptions about the discount rate and the rate of return to fixed capital, as well as the accuracy of the estimates of income and produced capital provided from the national accounts or other sources of financial information on fishing activity.

28. Table 2 below sets out the derivation using the national accounts values.

[3] SEEAF para.184 The formula given in SEEAF has been modified slightly to show net taxes on production.

Table 2

Residual resource rent calculations and estimate of the value of fish stock[1]

(NZ$000)

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Resource rent calculation:															
Total industry output	**TR**	**610**	**695**	**700**	**751**	**779**	**822**	**881**	**910**	**906**	**962**	**1,009**	**914**	**928**	**916**
less															
Intermediate consumption	IC	**399**	**440**	**443**	**494**	**487**	**516**	**573**	**575**	**545**	**585**	**627**	**616**	**643**	**632**
Compensation of employees	CE	**44**	**51**	**56**	**66**	**75**	**84**	**88**	**88**	**94**	**90**	**116**	**107**	**95**	**87**
Net taxes on production[3]	NT	**34**	**17**	**17**	**22**	**32**	**28**	**25**	**34**	**28**	**24**	**26**	**–2**	**19**	**21**
Consumption of fixed capital	CFC	**60**	**63**	**62**	**60**	**54**	**56**	**59**	**64**	**74**	**87**	**85**	**83**	**80**	**82**
Return to fixed Capital (8%)	NP	29	32	35	35	33	38	41	48	58	67	73	76	68	66
equals															
Resource rent	R	44	92	86	73	98	100	95	101	107	110	83	34	23	27
NP is calculated as 8% of the Net Capital Stock at start of year		366	**397**	**439**	**443**	**408**	**477**	**507**	**606**	**723**	**835**	**912**	**944**	**855**	**830**
Estimate of the value of the fish stock:															
Net present value of RR		491	1025	959	810	1094	1109	1060	1120	1192	1220	917	374	256	301
Fish Monetary Stock Account asset value[2]		1221	1878	2633	2642	2740	2726	2285	2599	2641	3097	3185	3601	3866	3730

1 National Accounts values are for March years, and are in current prices.

2 Values for the 1996-2007 years are official statistics published in the *Fish Monetary Stock Account*. Values for the period 1992-1995, although produced from the same data source, are considered indicative.

3 The 2003 figure is shown net of a return to the fishing industry of levies collected between 1994 and 2002.

E. Comparison of the valuations of NZ fish stocks

29. The residual value method is generally applied in those cases where there are no actual market transactions for the relevant resource. This is not the case in New Zealand which has a QMS regime in operation and quota trades occur. Therefore, in order to undertake a comparison between the valuations, it is important to ensure that all quota related transactions are excluded from income and expenditure in the industry, i.e. to calculate the GOS and hence the resdiual estimate of resourc rent as if there was no QMS.

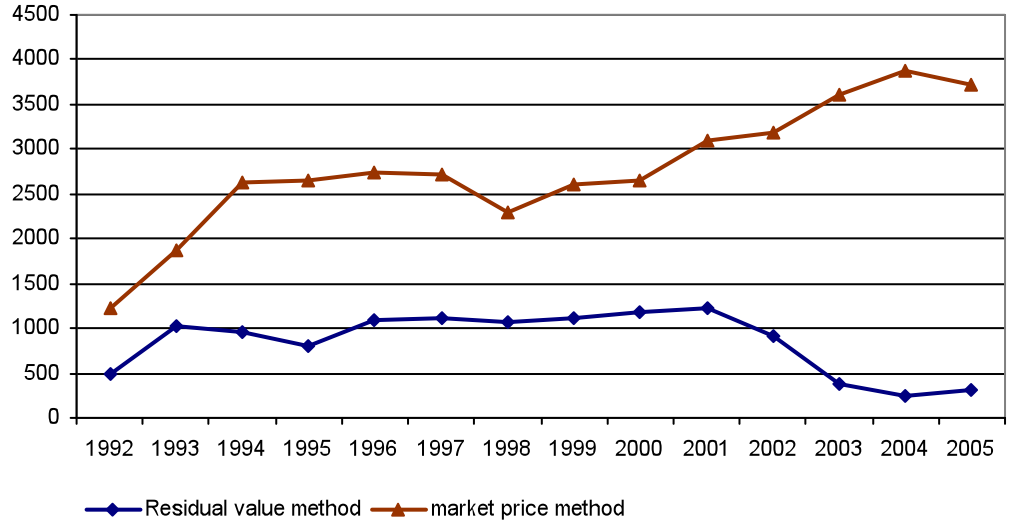
30. In practice, this is quite straight-forward and in fact requires no adjustments to the national accounts derived GOS because

i. ITQ are classified as intangible non-produced assets, and any trades are classified as capital transactions not current, and

ii. quota leases and/or ACE sales/purchases are classified as rent and are excluded from intermediate consumption. [4] Hence, the transactions shown in Table 2 exclude any related to actual sales / purchases of ACE or quota.

31. As can be seen in Figure 1, the final asset value figures calculated from the residual method differ substantially from the market valuation estimates although there was some consistency in the trend observed until 2001.

Figure 1: Fish Stock Valuations
$(000)



32. The size of these differences led to substantial amount of research and the main avenues of investigation and key findings are mentioned here.

a. *Coverage of the Quota Management System.* Two angles were investigated here. First, whether there were a sufficient number of market transactions to consider that the information on the ITQ and ACE transactions could be considered sufficiently representative of the fishing industry as a whole. On this point there are a reasonable number of ITQ trades – roughly 1000 per year and up to 70,000 ACE trades per year. This suggests that there are sufficient transactions in the market for the results to be considered robust. Second, what proportion of the fish stock was subject to the QMS. On this point it has been estimated by the NZ Ministry of Fisheries that the QMS accounts for over 95% of the total commercial catch.

b. *Scope of fishing activity recorded in the national accounts.* There are a number of consideration in this area. First, on investigation it became clear that not all of the fishing activity in NZ was being undertaken by units classified to the fishing industry. In fact many units were classified to the fish processing industry and in order to get more complete estimates of the residual resource rent based on national accounts data, a number of industries needed to be combined. At the same time it was important to exclude from the national accounts any non-fishing activity and/or non-managed fishery activity that might be contributing to the gross operating surplus.

[4] Note that an adjustment for net non-life insurance premiums, a current transfer implicitly included in GOS should be made. However, as this value is quite small and would not materially alter the results for this exercise, this refinement has not been done.

c. *Transfer pricing.* More specifically, building on the previous issue, investigation revealed the need to possibly adjust for transfer pricing of quota leases or fish, which will not necessarily be confined to vertically integrated enterprises. This reinforces the previous point, i.e. the need for comprehensive coverage of the industry, as, in aggregate, transfer pricing may net out.

d. *Expected versus actual catch.* In applying the residual value approach the question arose as to how to adjust a fluctuating residual resource rent that is based on actual catch volumes to reflect a value based on expected volumes consistent with sustainable catch limits. Investigation suggested that while the actual catch was below the allowed catch, the difference being around 10%, this difference was not sufficient to account for the difference in the results obtained. (There is also the more complex issue of adjusting fluctuating resource rents in non-sustainable fisheries with the associated complications of partitioning the residual net operating surplus between income and depletion. This was not explored in the NZ study.)

e. *Accounting versus economic valuations.* Underpinning the market prices are likely to be cost structures based on historic valuations of fixed capital as opposed to the economic or replacement cost valuations that are used in the national accounts. Adjusting for this potential difference by using book values of fixed capital in the residual value approach made little difference in the NZ case.

f. *Quality of survey data.* There are difficulties in getting survey respondents to correctly classify transactions. Nonetheless, in the New Zealand study many of the possible data errors only arose because the accounts were being artificially adjusted to remove those transactions associated with quota / ACE trades. In the absence of such trades, these particular types of possible errors will not arise – although one suspects that others will. Overall, the residual value method places a premium on data quality and requires an accurate value for gross operating surplus.

g. *The choice of model parameters.* The SEEA discusses issues relating to the choice of discount rates and rates of return on fixed capital and these clearly have an impact on the value of the derived resource rent and resulting NPV. The presence of market trades in both quota and ACE in New Zealand allowed an implicit discount rate to be determined. Over time this appeared to track the 5-year Treasury bond rates. For the rate of return on fixed capital, as this was being applied to assets valued at historic costs, a nominal exogenous rate based on the commercial bank base lending rate plus 2 percent to reflect industry risk was used. This is indicative only and is not based on the actual rates faced by the industry. It is not being suggested that the rates chosen in the New Zealand paper can be applied elsewhere – the point is that the choice of rates, especially discount rate, can have a major impact on the fish stock values. However, given that the same rates were chosen in the application of NPV for the market based approach and the residual value approach the choice of rates does not explain the differences in the resulting estimates of the value of the fish stock.

33. As a result of this comprehensive analysis the NZ study drew the following conclusions of relevance to the revision of the SEEA.

a. When (i) there are a relatively large number of market transactions in quota, (ii) quota are allocated in perpetuity and (iii) the fishery is managed on a sustainable basis, then the market value of all quota provides a good valuation of the fish stock. Therefore SEEA-2003 paragraphs 7.272 and 7.273 are supported.

b. Where estimates of resource rent are based on annual quota sales - or, as in the case for New Zealand, Annual Catch Entitlement (ACE) sales - then the resource rent estimate can be considered robust and NPV methods can be adopted to estimate the value of the stock. In New Zealand, this approach provided similar estimates of the value of the fish stock to those estimated using direct market methods.

The proviso is that similar regulatory and market conditions hold, viz. a sustainable fisheries management regime and free trades in ITQ/ACE. The New Zealand illustration indicates that in stable and sustainable fishery management regimes, fishers exhibit rational market behaviour in ITQ and ACE markets. This leads to an alignment of resource rents based on either ITQ or ACE market prices, implying a discount rate that changes overtime in line with market rates. Again, SEEA-2003 paragraph 7.273 is supported.

c. Where estimates of the resource rent are derived residually the application of NPV methods appears to produce quite different results. The paper attempts to replicate a fishery regime in which no quota markets exist but all other conditions are the same (sustainable management, free entry etc). The New Zealand data indicates that the residual resource rent value derived in this regime is significantly lower than either the resource rent implicit in the actual quota sales values or the estimated resource rent based on annual ACE sales (which is a direct measure of resource rent). The results suggest extreme caution when using a residual value approach to calculating resource rent.

F. Further consideration of discount rates

34. 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. 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 rate to be used in estimating an asset's value is a pivotal variable and is often the subject of considerable debate[5].

35. Within the New Zealand study for the market price approach, the choice of discount rate is only an issue for that portion of the fish stock valuation that is reliant on the NPV of the ACE. This applies post 2001 only. While the direct valuation of quota sales remains the predominant valuation source, the portion valued using the ACE method has increased, averaging just over 40 percent for the period 2005-07.

36. The draft SEEA-Fisheries lists discount rates used by five countries in preparing their fisheries asset values[6]. The rates varied from a low of 3.5 percent in Norway to a high of 10 percent in Namibia. This account uses a discount rate of 9 percent and is chosen because 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 capture-fish harvest rights in New Zealand are freely traded and owned entirely by private individuals and organisations[7].

37. 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 also be considered. This produced an implied discount rate of between 8-9 percent. In addition, Newell (2002) examined the relationship between Quota sales and lease prices[8] and found that the implicit rate inferred by the relationship was, for the relevant years of this

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[5] 2003 SEEA 7.188

[6] 2004 SEEAF 202

[7] 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.

[8] Newell (2002) examine the data over the period 1986–2000, i.e. before the establishment of ACE.

exercise, between 11 percent (in 1992) to 7 percent (in 1999). Interestingly, they found that the implied rate declined broadly in line with the fall in real interest rates over the period.

38. In the context of the broader application of NPV approaches this evidence from the NZ study suggests that discount rates can be observed and should be used but that careful consideration of the relevant market conditions should be undertaken in choosing a discount rate.

G. Conclusions for the SEEA revision

39. The case study on the valuation of fish stocks in New Zealand highlights a number of important issues for the revision of the SEEA. Specifically with regard to fish stocks the work supports the current approach to the valuation of fish stocks outlined in the SEEA-2003 and it is recommended that this approach continue to be described in the revised SEEA.

Recommendation 12.1: That the use of information on quotas and related trading schemes can be used to obtain robust values of fish stocks and hence the proposed methods relating to the valuation of fish stocks described in the SEEA-2003 should be retained in the revised SEEA.

40. More generally there are important lessons regarding how to undertake the valuation of natural resources that should be taken into account in the revised SEEA. First, particular care must be taken in the estimation of resource rent. Where it can be estimated in a direct fashion based on market transactions then, provided the market is sufficiently large and the natural resource is being managed sustainably, then the estimates of resource rent should be considered robust.

41. However, where resource rent must be estimated in a residual manner based on estimates of output, intermediate consumption and other variables for relevant industries, considerable care must be taken as the resulting estimates may not be strong. The case study highlighted a range of issues concerning the residually based estimates of resource rent.

42. Second, the use of NPV methods to derive estimates of the value of a natural resource is appropriate but the quality of the results depends on the quality of the estimate of resource rent that is used. Using poor quality estimates of resource rent within an NPV formula will result in poor quality estimates of the value of the natural resource. Conversely, using robust estimates of resource rent within an NPV formula will result in robust estimates of the value of natural resources.

43. Third, discount rates can be observed but there should be careful consideration of the relevant market conditions before choosing a discount rate.

44. Finally, all of the valuation approaches in the case study assumed that the fish stocks were a renewable resource being managed sustainably. Consequently, there was no requirement to consider the measurement of depletion of the fish stock. In cases where the fish stocks are not being managed sustainably, the methods described in the case study may not be appropriate since the market price signals may not capture the depletion cost.

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