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# Monetary Value Assessment of Clam Fishing Management Practices in the Venice Lagoon: Results from a Stated Choice Exercise

## Summary

This article focuses on the economic valuation of alternative clam management practices in the Venice Lagoon. The proposed valuation method is characterized by the design of a survey questionnaire next to the fishermen population. In each questionnaire two fishing alternatives are described. The respondent is asked to choose one of them. This valuation method, referred in the article as conjoint valuation, gives sufficient flexibility to set, alter, and combine different management practices. Furthermore, this approach presents an important advantage to the well-known contingent valuation method since it makes the monetary valuation of each management attribute possible. Estimation results of the random utility model show that fishermen's willingness to pay for a larger clam fishing area is approximately 568 € per year. In addition, an individual fisherman would be willing to pay 1,005 € for a change from today's fishing situation practice towards a fishing practice exclusively based on vibrant rake system. If we take into account the interaction between fishing management attributes and fishermen characteristics, we can see that the valuation of each management practice differs substantially across the two populations. We can observe that the population of fishermen that operate in the cooperative regime presents not only a higher monetary valuation for an increase in the dimension of the fishing concession, which is now valued at 811 €, but also a stronger willingness to pay for a change from today's fishing situation towards a fishing practice exclusively based on vibrant rake system, which is now estimated at 2,456 €. Finally, the adoption of a clam fish management practice in Venice Lagoon that is exclusively based on the use of manual rakes, which is associated to the lowest damage to the Lagoon ecosystem, will represent a welfare loss of 5,904 € per fisherman per year. Combining this value with the total number of fishermen currently operating in the Lagoon of Venice, the welfare loss associated with the adoption of such clam management policy that is exclusively based on the use of manual rakes amounts to 11.8 € million per year. This figure can be regarded as an upper bound to the cost of implementation of a clam fishing system anchored in the use of manual, ecosystem friendly rakes.

**Keywords:** Exotic marine species, Fishing rakes, Manila clam, Fishing effort, Open access, Welfare damages, Policy guidance, Permit price.

**JEL:** C25, C29, D62, H41, Q20, Q25, Q30

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## **I. Introduction**

This article focuses on the estimation, and discussion, of the economic valuation results of alternative clam fishing management practices in the Lagoon of Venice. The proposed valuation approach is anchored in the use of the stated preference methodology and it is characterized by the design of a contingent choice survey, which was carried out by personal interviewers (see ‘Exploring the use of stated preferences methods to value fish management practices’ for more details on the involved econometric modeling and survey design aspects). The organization of the article is as follows. Section 2 describes the recent fish management practices, as a result of the introduction of exotic clam species in the Venice Lagoon. Section 3 discusses the range of the economic estimates and evaluates these for different policy scenarios. Section 4 concludes.

## **II. Statement of the natural resource problem**

### ***A. Clam fish management practices in the lagoon of Venice***

Clam fishing in the Lagoon of Venice comes from several fishing activities. These include fishing in lagoon canals and water areas; valley fishing; farm fishing (aquaculture); and clam fishing (CVN 1999). These activities involved the harvest of two endemic species, *Tapes decussatus*, and *Scrobicularia plana*. Originally, clam fishing relied on manual rakes and triangular iron dredges, also known by the local fishermen population as ‘cassa’. Such a traditional fishing practice goes back to the *Serenissima Republic* as was characterized by many restrictions. For example, nets had to conform to pre-determined models, their mesh needed to be of a certain dimension, and fishing was absolutely forbidden in some periods of the year (see Ninni 1940, Pellizzato and Giorgiutti 1997). Until recently, clam fishing activity in the lagoon continued to be strongly regulated. The local authority together with fishing cooperatives controlled the fishing activity by fixing prices and amounts of catch, as well as defining and managing specific areas in the lagoon (Bevilacqua 1998). Furthermore, until the end of the Second World War motorboats were limited to the port of Chioggia. Elsewhere in lagoon there were only rowing and sailing boats. Their main fishing systems were limited to trawl nets, fyke-nets, gillnets, seine nets, and other manual equipments (Brunelli *et al.* 1940, Zolezzi 1944).

Today more than 2,000 people are employed in the clam fishery sector. The current clam fishing practice is characterized by an open access situation. In other words, in order to fish in the Lagoon, it is necessary to buy a license. There is no limit of the total licenses issued per fishing season. This fact together with the high revenues associated with clam fishing have

encouraged an increasing fishing effort, resulting in the adoption of technological intensive equipment and the progressive abandon of the traditional fishing practices (Pellizzato and Giorgiutti 1997). In this context, the Lagoon has been assisting the widespread of mechanical and vibrating fishing equipments, including the use of suction dredgers and rakes for harvesting clams (see Figure 1).

\*\*\* Introduce Figure 1 about here \*\*\*

### ***B. The introduction of the exotic clam species***

The clam fishing effort in the Lagoon has strongly increased since 1983, coinciding with the introduction of *Tapes philippinarum*, also called the Manila clam in the Lagoon. This exotic species originally comes from the Indo-Pacific region and it has rapidly adapted to the lagoon environment. Now it is responsible for colonising large shallow areas and competing directly in the ecological niche with the endemic clam species. Furthermore, the relatively high market price of this species, ranging from 1.6 to 3.6 euro a kilogram, has contributed to an increase of the Manila clam fishing profitability. Because of the open access situation, many operators came into this activity. Most of them adopted mechanical equipment, such as the vibrating rake technology, used exclusively for the harvest of this shellfish. All together, this has led to significant in the fish management practices. For example, in 1998, the fishing fleet was composed of about 600 vessels, 84 of which used vibrating rake technology. The vibrating rake is equipped with an electrical cage, shaking and filtering sediment mechanisms with a capacity to harvest 150 to 200 kg of clam shellfish a day (Pellizzato *et al* 2000). Manila clams live at water bottom and for this reason they are very sensitive to water movements and to deposit and accumulation of water sediments (Orel *et al.* 1997). Since the harvest of this shellfish implies sediment movements, these have become exceptionally significant with the introduction of mechanical and vibrating fishing equipments. Therefore, the adoption of these vibrating technologies has brought unavoidable negative environmental impacts on the morphology, processes and marine life functions of the Lagoon (ICRAM 1994, Pranovi and Giovanardi 1994, Sfriso 2000).

These management practices are currently are far and away from being a sustainable economical activity as they have been causing unprecedented damages to the marine system. For example, market data shows a diminishing supply of approximately 40% between 2000 and 2001 due to a reduction in the clam's stock (see Granzotto *et al.* 2002 for additional details). To make matters worse, such a heavy fishing pressure has been followed by an

increased pollution in the Lagoon due to the neighborhood industrial activities, such as the oil refineries located at Marghera. These have also contributed to causing significant environmental damage to the marine ecosystem, including the destruction of nursery areas and feeding grounds of many commercial fishes.

In such a context, the economic valuation of alternative clam management practices is of central importance since it sheds light on the involved welfare changes (see van den Bergh *et al.* 2002, Nunes and van den Bergh 2002). These can be compared with the benefits derived from protecting the Lagoon from environmental damage across alternative policy scenarios. Valuation results are presented and discussed in the following section.

### **III. Monetary valuation results**

The questionnaire was carried out in summer 2001. The sampling was executed across the two main areas of the Lagoon: the northern area, including Burano, and the southern area. The questionnaire was performed by face-to-face interviews, involving the participation of researchers with high levels of field knowledge as the interviewers. The interviewers contacted 193 fishermen, 114 of which completed the questionnaire. The non-participation rate is therefore about 40 percent. Figure 2 shows the descriptive statistics of the survey responses.

\*\*\* Introduce Figure 2 about here \*\*\*

The present questionnaire only contains one section, the contingent choice question. The empirical specification of the random utility model is characterized by decomposing the systematic utility component in terms of price of the permit, area of fishing concession, and the type of fishing system. The valuation results are presented in Table 1a. First, we can observe that all explanatory variable estimates reveal to be statistically significant at the 90 percent level indicating that respondents receive an utility change whenever these change. Second, estimation results show that the probability of the choice of a management practice is positively related to the dimension of the fishing concession area, i.e. any policy option that is characterized by increasing the fishing area is *ceteris paribus* associated with an increase of the utility and therefore supported by the fishermen. Third, the choice of a management practice reveals to be negatively related to its associated costs, reflecting the fact that higher prices result in lower utilities. Finally, the choice of a management practice reveals to be positively related to its degree of technology, measured in a three-level attribute. In other

words, any policy option that is characterized by the exclusive use of a vibrant rake is, *ceteris paribus*, associated with a positive impact in fishermen's welfare and thus connected with a higher probability of choice.

\*\*\* Introduce Table 1a and Table 1b about here \*\*\*

In the present application, stated preference results are used to predict the monetary impact of changing the dimension of the fishing area and type of fishing system on fishing behavior. Monetary valuation results show that the amount of money that an individual fisherman would be willing to pay for a change in the dimension of the fishing concession is 568 €. In addition, Table 3b shows that the economic welfare impact of a change in the clam management practice, due to a change in the fishing system amounts to 1,005 €. In other words, an individual fisherman would be willing to pay 1,005 € for a change from today's fishing situation towards a fishing practice exclusively based on the vibrant rake system.

We can also observe that only a relatively small part of the variance of the observed stated preference behavior can be explained by these fishing-related-attributes, the  $R^2$  is about 19 percent. As a consequence the respective monetary valuation results are characterized by relatively wide interval estimates. For example, according to Table 3b, fishermen's WTP for a larger fishing concession ranges between 125 € and 1,732 €. In order to improve MNL estimation results, we study the degree to which preferences for fishing programs differ between the two segments of the fishermen population. In this context, two fishing segments were defined, corresponding to two types of fishing regimes in the Venice Lagoon. One fishing regime refers to a fishing fleet that is composed of vessels jointly managed by cooperatives. The other refers to a fishing regime that is characterized by smaller and individually owned vessels. While the former are currently submitted to a set of cooperative managing rules, the latter are often managed by private individuals, who predominantly fish as a complementary income source to their main economic activity. In addition, some of these individuals are unauthorized or illegal fishermen.

Therefore, we explore an additional model formulation, see Table 2a, which includes interactions of operations in collective regime and operations in individual regime (individual characteristics) with the attributes originally under consideration at the stated preferences model. In fact, the introduction of such information contributed to a significant qualitative improvement of our econometric model. This is now capable of explaining more than thirty percent of the variance of the observed stated preferences behavior – see  $R^2$  in Table 2a.

As before, estimation results show that as the price of the permit increases, utility decreases. Similarly, as the concession area increases, utility increases. In addition, regime interactions coefficients are added to the main effects for fishermen who operate in the cooperative regime. Since fishermen who operate in the individual regime are coded as zero, we can see that fishermen who operate in the cooperative regime present a higher sensitivity to the price of the permits, see the estimate for regime\*price cross effect in Table 2a. In fact, for the population that operate in the individual regime, a price increase is characterized by a negative impact in the utility and estimated to be of the magnitude  $-0.0007$ . In contrast, the fishermen population who operate in the cooperative regime this impact decreases to  $-0.0028$  ( $= -0.0007 - 0.0011$ ). Independently of the type of fishermen, price estimates are statistically significant indicating that, everything held constant, fishermen continue to receive more utility from lower prices.

\*\*\* Introduce Table 2a and Table 2b about here \*\*\*

We can also observe that a change in the dimension of the concession area presents stronger impact on the utility of the population of the fishermen who operate in the cooperative regime than on fishermen who operate in the individual regime, 1.167 and 0.5814 respectively. Finally, estimation results show that the welfare impact of a change in the fishing system differs substantially across the two fishermen populations, which is particularly strong for the fishermen who operate in the cooperative regime. Such parameter estimates are reflected in the economic welfare measurements – see Table 2b. In fact, when comparing these valuation results with the ones presented in Table 1b, which represents the polled fisherman population, we can observe that the population of fishermen who operate in the cooperative regime present higher monetary valuation for an increase in the dimension of the fishing concession, which is now valued at 811 €. In addition, this population is characterized by a stronger willingness to pay for a change from today's fishing situation towards a fishing practice exclusively based on vibrant rake system, which is now estimated at 2,456 €.

Finally we address a policy issue related to the economic value assessment exercise of a change in the clam management practice in Lagoon Venice due to an adoption of a clam system exclusively based the use of manual rakes, which are described as the showing the lowest environmental damage. In other words, how much would it cost to pay all fishermen, independently of their current fishing equipment, to adopt such an environmental friendly clam fishing technology? According to our calculations – see Table 3a and 3b – the financial

costs associated with the adoption of such a policy is estimated to be 5,904 € per fisherman per year, ranging up to a maximum of 80,160 € per fisherman per year, depending on the type of fishermen population and current management practice. Combining this value with the total number of fishermen currently operating in the Lagoon of Venice, the total welfare loss associated with the adoption of the manual clam fishing technology is estimated to at 11.8 € million per year. This information is crucial for the evaluation of the costs due to the adoption of a clam fishing system based on the use of manual rakes. In this context, this figure can be regarded as an lower bound to the benefits of implementation of a clam fishing system based associated with the lowest environmental damage in the Lagoon.

#### **IV. Conclusions**

This article focused on the economic valuation of alternative clam management practices in the Lagoon of Venice. The proposed valuation method is characterized by the design of a questionnaire. Estimation results show that: (1) fishermen bear an utility change whenever the price of the annual permit, the fishing technological system and the dimension of the fishing area change; (2) the probability of the choice of a management practice is positively related to the dimension of the fishing concession area and the level of technology. In other words, any policy option that is characterized by the exclusive use of the vibrating and scrapers fishery system is associated with a positive impact in fishermen's welfare. Furthermore, (3) the choice of a management practice reveals to be negatively related to its associated costs, reflecting the fact that higher prices of the annual permit result in lower utilities.

In addition, economic results show that individual fisherman value: (1) positively the enlargement of the fishing area (ranging from 568 € to 811 €, ha/year); (2) positively the change from today's fishing situation practice towards a fishing practice exclusively based on the vibrant rake system (ranging from 1,005 € to 2,455 €, year); (3) negatively the change from today's fishing situation practice towards a fishing practice exclusively based in the use of manual, ecosystem friendly rakes (5,905 € to 80,160 €, year). Furthermore, combining the valuation results with the fishermen population (2,000) means that the adoption of a clam fishing management practice that is exclusively based on the use of the manual rakes will be associated with a welfare loss that ranges from 11.8 € to 160.3 € million per year. Such a range reflects that the welfare impact of a change in clam management practices differs substantially across the population of fishermen that operates in the cooperative regime and the population of fishermen that operates in the individual regime. Finally, from a policy perspective the adoption of a clam fish management practice anchored in the use of manual,



ecosystem friendly rakes, and associated forgone environmental damages on the morphology processes and marine life functions, will require an annual a lump sum payment to the fisherman population that amounts to no less than 11.8 €million per year.

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Table 1a: Stated preferences model estimates <sup>(a)</sup>

Variable	Estimate	p-value
Price of the permit	- 0.0006	0.000 *
Area	0.3340	0.005 *
Fishing system <sup>(b)</sup>	- 0.6017	0.085 **
Adjusted R <sup>2</sup>	0.1911	

Table 1b: Economic welfare measurement

WTP for	Point estimate	95% Confidence Interval <sup>(d)</sup>
Area	568 € (1.70) <sup>(c)</sup>	[125 € ; 1 732 €]
Fishing system <sup>(b)</sup>	1 005 € (1.36) <sup>(c)</sup>	[- 119 € ; 3 236 €]

Notes:

\* (\*\*) Statistically significant at 5% (10%).

<sup>(a)</sup> Calculations are performed using the MULTINOMIAL LOGIT procedure in *LIMDEP*<sup>®</sup>.

<sup>(b)</sup> Ordinal categorical variable with 0 = today (benchmark), 1 = manual, and - 1 = vibrant.

<sup>(c)</sup> t-values are computed using the delta method.

<sup>(d)</sup> CI is estimated using the asymptotic t-test method as described by Armstrong *et al.* (2001).

Table 2a: Stated preferences model estimates with cross effects for the fishing regime <sup>(a)</sup>

Variable	Estimate	p-value
Price of the permit	- 0.0007	0.008 *
Area	0.5814	0.008 *
Fishing system <sup>(b)</sup>	- 1.7661	0.013
Regime <sup>(c)</sup> * Price	- 0.0011	0.316
Regime <sup>(c)</sup> * area	0.5856	0.492
Regime <sup>(c)</sup> * system	4.2996	0.052 *
Adjusted R <sup>2</sup>	0.3023	

Table 2b: Economic welfare measurement

WTP for	Point estimate	95% Confidence Interval <sup>(e)</sup>
Area	811 € (1.97) <sup>(d)</sup>	[225 € ; 2 917 €]
Fishing system <sup>(b)</sup>	2 456 € (1.84) <sup>(d)</sup>	[403 € ; 8 340 €]

Notes:

\* (\*\*) Statistically significant at 5% (10%).

<sup>(a)</sup> Calculations are performed using the MULTINOMIAL LOGIT procedure in LIMDEP<sup>®</sup>.

<sup>(b)</sup> Ordinal categorical variable (0 = today, 1 = exclusively manual, - 1 = exclusively vibrant).

<sup>(c)</sup> Regime is a dummy variable with 1 denoting regime cooperative and 0 regime individual.

<sup>(d)</sup> t-values are computed using the delta method.

<sup>(e)</sup> CI is estimated using the asymptotic t-test method as described by Armstrong *et al.* (2001)

Table 3a: Model estimation with cross effects for the fishing regime <sup>(a)</sup>

Variable	Estimate	p-value
Price of the permit	- 0.0003	0.030 *
Area	0.2787	0.031 *
Fishing system = Manual	- 1.8644	0.013 *
Regime <sup>(b)</sup> * Price	- 0.0015	0.170
Regime <sup>(b)</sup> * area	0.8888	0.292
Regime <sup>(b)</sup> * manual	4.4041	0.048 *
Adjusted R <sup>2</sup>	0.3023	

Table 3b: Economic welfare measurement

WTP for	Point estimate	95% Confidence Interval <sup>(d)</sup>
Fishing system = Manual	- 5 904 € (1.66) <sup>(c)</sup>	[- 80 160 € ; - 953 €]

Notes:

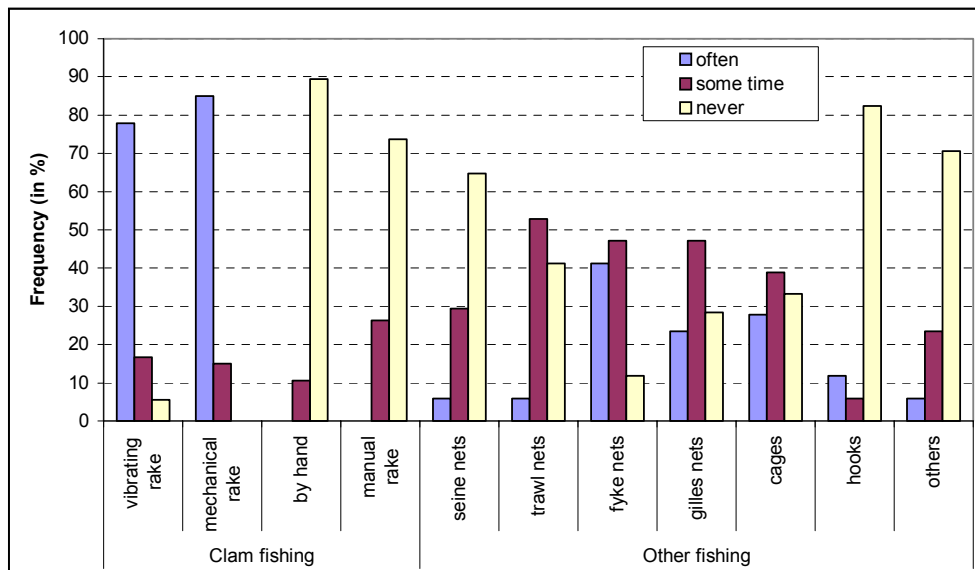
\* Statistically significant at 5%.

<sup>(a)</sup> Calculations are performed using the MULTINOMIAL LOGIT procedure in LIMDEP<sup>®</sup>.

<sup>(b)</sup> Regime is a dummy variable with 1 denoting regime cooperative and 0 regime individual

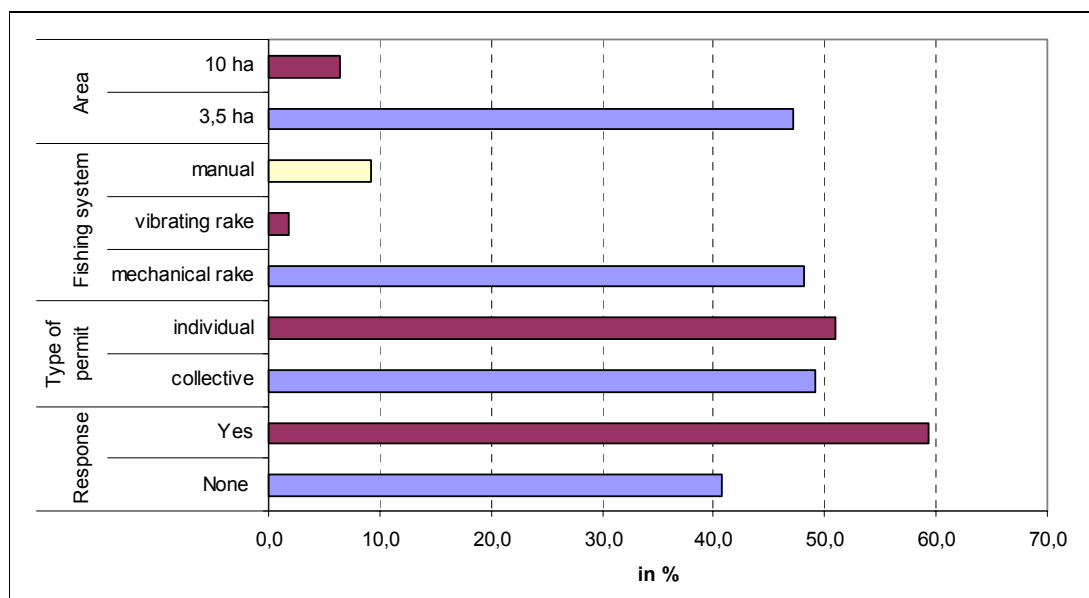
<sup>(c)</sup> t-values are computed using the delta method.

<sup>(d)</sup> CI is estimated using the asymptotic t-test method as described by Armstrong *et al.* (2001)



Source: Boatto et al. (2002)

Figure 1 - Diffusion of fishing equipments in the Lagoon of Venice



Source: Boatto et al. (2002)

Figure 2 - Descriptive statistics of contingent choice questionnaire

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- (liii) This paper was circulated at the International Conference on “Climate Policy – Do We Need a New Approach?”, jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001
- (liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002
- (lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001
- (lvi) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy “The International Dimension of Environmental Policy”, organised with the collaboration of the Fondazione Eni Enrico Mattei, Acquafredda di Maratea, October 6-11, 2001
- (lvii) This paper was presented at the First Workshop of “CFEWE – Carbon Flows between Eastern and Western Europe”, organised by the Fondazione Eni Enrico Mattei and Zentrum für Europäische Integrationsforschung (ZEI), Milan, July 5-6, 2001
- (lviii) This paper was presented at the Workshop on “Game Practice and the Environment”, jointly organised by Università del Piemonte Orientale and Fondazione Eni Enrico Mattei, Alessandria, April 12-13, 2002
- (lix) This paper was presented at the ENGIME Workshop on “Mapping Diversity”, Leuven, May 16-17, 2002
- (lx) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by the Fondazione Eni Enrico Mattei, Milan, September 26-28, 2002
- (lxi) This paper was presented at the Eighth Meeting of the Coalition Theory Network organised by the GREQAM, Aix-en-Provence, France, January 24-25, 2003

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