

**THE PALOLO HARVEST [*PALOLA (EUNICE) VIRIDIS*]  
IN AMERICAN SAMOA  
2001 & 2002**

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## ABSTRACT

Palolo [*Palola (Eunice) viridis*] surveys were carried out in 2001 and 2002 in the South coast of Tutuila Island – American Samoa. The peak of swarming occurred on 8<sup>th</sup> November 2001 and 27<sup>th</sup> October 2002. Sampling areas extended from Faga'alu to Nu'u'uli (Central area) and from Lau'i'I to Utumea (Eastern area). Sampling protocols consisted of i) counting fishing participants during drive "run" along the coast in order to evaluate the fishing effort, and ii) interviewing fishermen to estimate Catch Per Unit Effort (CPUE).

In 2001 and 2002, effort was 977 and 2,155 participants whilst CPUE corresponded to 0.18 kg.participants<sup>-1</sup>.hr<sup>-1</sup> (0.39 lb) and 0.64 kg.participants<sup>-1</sup>.hr<sup>-1</sup> (1.41 lb) respectively. The total harvest expanded to all participants was 172 kg (379 lbs) in 2001 and 1,386 kg (3,055 lbs) in 2002.

Comparisons with surveys completed in 1991 and 1992 are provided.

## 1. INTRODUCTION

Palolo worms from the South Pacific are relatively well studied, because the annual risings are not only major festivities for the locals, but have also attracted the attention of biologists and anthropologists since the 18th century. It was noted that the swarming worms were headless. For a long time, it was a mystery where the heads were. Gray's (1847) first scientific description of a Samoan Palolo worm was based on the headless portion only, later called the epitoke. He called the species *Palola viridis*, the genus name being derived from the Samoan name, and the species name meaning green. At the end of the 19th century, Friedländer (1898) and Krämer (1899) independently discovered that the worms spend most of their lifetime burrowing in hard substrate. Only once a year, their hind ends break off and swim spiralling to the surface to shed eggs and sperm. This reproductive frenzy only lasts for a few hours. Over the course of the next year, the head ends (or atokes) regenerate and eventually produce new epitokes (Smithsonian National Museum of Natural History, <http://web8.si.edu/nmnh/palola/intro.html> ).

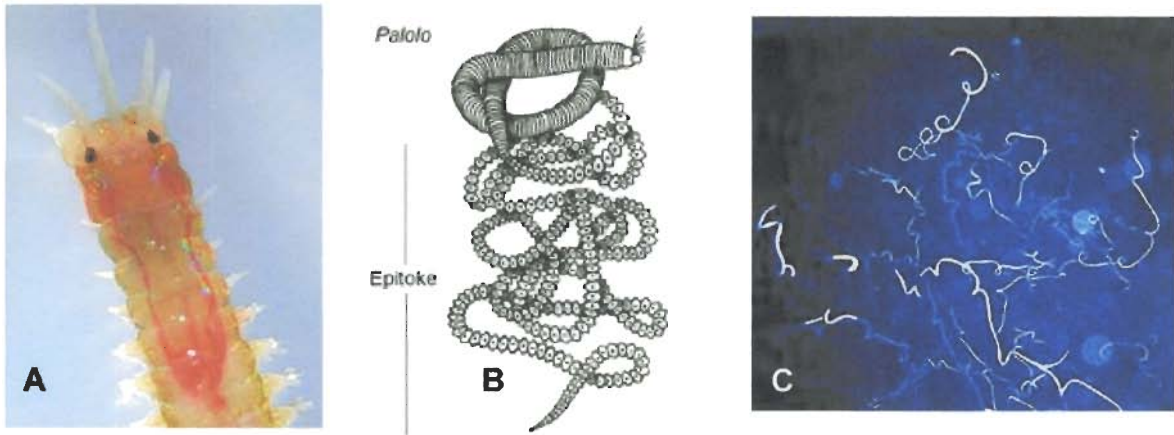


Figure 1: *Palola (Eunice) viridis*.

A - Details of the head; B - Epitoke part; C - Epitokes in situ

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Figure 2: Catches of Palolo

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Itano & Buckley (1988) and Itano (2002) summarized general information on the swarming of palolo in American Samoa as follow:

*[The "epitoke" contains reproductive gametes colored blue-green (females) or tan (males). Each epitoke segments bear a single, tiny eyespot that can sense light, that's why islanders are able to use a lantern to attract the palolo to their nets. When it is time to spawn, palolo will back out of their burrows and release the epitoke section from their body. The epitokes then twirl around in the water in vast numbers and look like dancing spaghetti. Around daybreak, the segments dissolve and release the eggs and sperm that they contain. The fertilized eggs hatch into small larvae that drift with the plankton until settling on a coral reef to begin life anew.]*

*The swarming of palolo is a classic example of the coordinated mass spawning of a simple marine organism. The worms emerge from their burrows during a specific phase of the moon, but the actual date is a bit complicated.*

*The swarms occur on the evenings of the last quarter moon of spring or early summer. In Samoa, this is seven days after the full moon in October or November. Swarming occurs for two or three consecutive nights with the second night usually having the strongest showing. Palolo usually appears in American Samoa in October, but sometimes in November or sometimes during both months. This difference is due to the fact that there are approximately thirteen lunar months in one calendar year and the palolo primarily use the moon to time their spawning activity. However, if they always spawned every twelve lunar months, their time of spawning would occur earlier every year. After a few years, they would be spawning in August or July (midwinter). In order to make up for this difference, the worms will delay spawning in some years to the thirteen lunar month.*

*The fact that palolo adjust their spawning time means that there are other factors beside the moon that determine the time of year they begin to mature and are ready to release their epitokes. Several studies on this matter have suggested that rising seawater temperatures, tides, weather, moonlight or other biological signals may play a role in starting the maturation and release of the epitokes. Once the swarming begins, the presence of the palolo spawn in the water probably stimulates other palolo to release their mature epitokes.*

Rules For Predicting Emergence (Caspers, 1984). Everyone seems to have their own methods for predicting when the best palolo rising will occur. Several natural clues that preceded the palolo rising enabled islanders to predict the correct timing for palolo swarming. These included the flowering of the moso'oi tree, the closing of the palulu flower (a morning glory), a strong smell from the reef, brown foamy scum (from coral spawn) on the ocean, toxins occurring in reef fish, and abrupt weather changes or bad weather such as thunderstorms or lightning.

So, will palolo swarm seven days after the full moon in October or November? One set of rules used to predict the main night of emergence depends on the calendar date of October's third quarter moon (seven days after October's full moon). If it occurs:

1. From October 1 to 8, palolo will not appear until November.
2. From October 8 to 18, palolo will not appear in October or the swarming will be weak followed by a stronger appearance in November.
3. From October 19 to November 7, there will be a single, strong swarming centered on this date.
4. From November 8 to 17, there will be a strong appearance on this date, possibly following a weaker swarming during the previous month (see number 2 above).

To further complicate matters, the actual time of emergence of palolo in Samoa differs between islands. They usually appear around 10 pm in the Manu'a Islands (however, it has occurred at 1 am there), 1 am on Tutuila and closer to 4 or 5 am in western Samoa. This difference is somewhat consistent from year to year and cannot be accounted for by difference in tides or moonrise. The difference in tides between islands is far less than one hour and the time of moonrise is only minutes apart].

"Palolo" as it is traditionally referred to, is a delicacy for the natives. Thus, harvest time for palolo is an annual event not to be missed.

## 2. METHODS

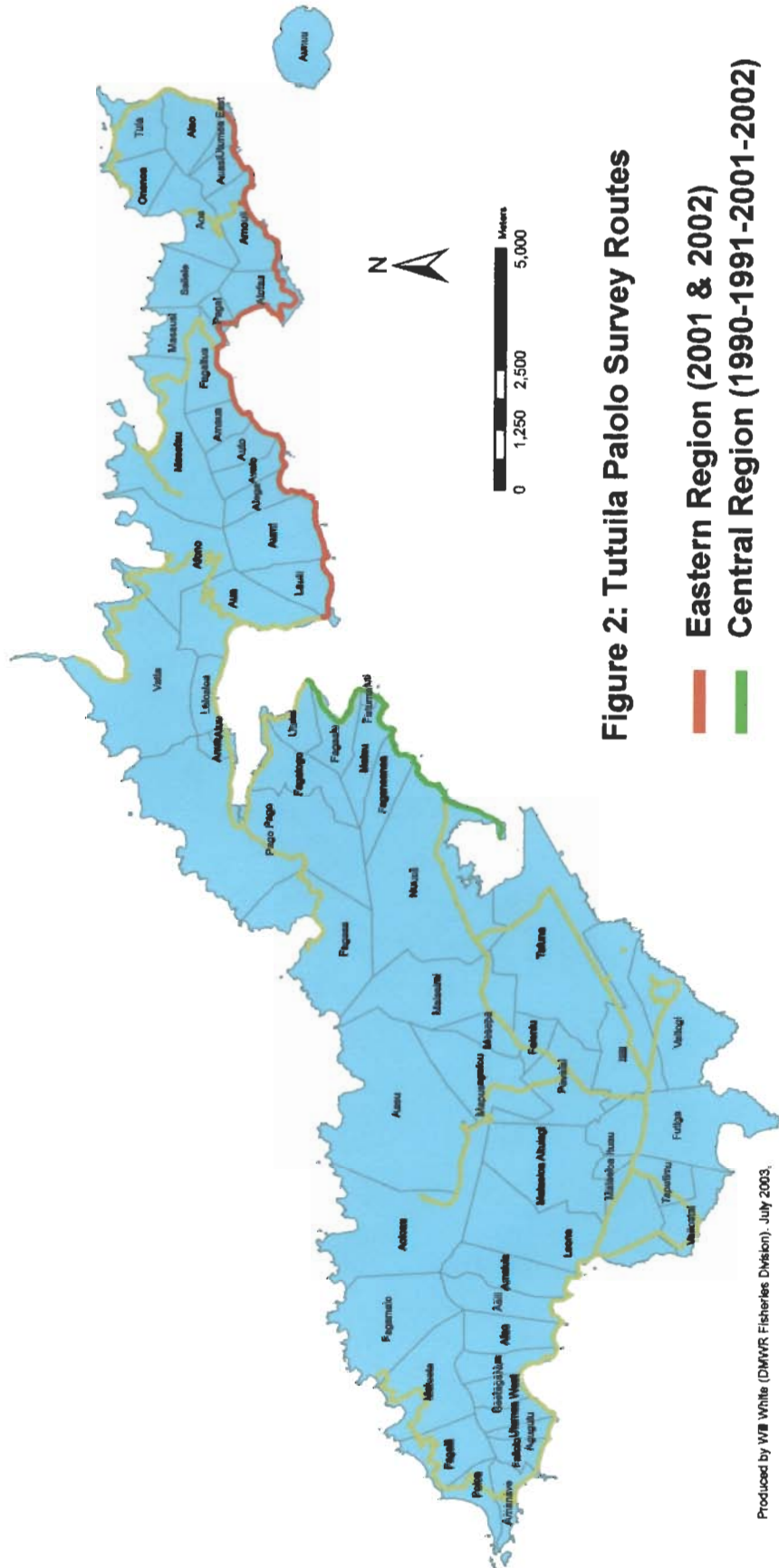
### 2.1. Sampling area

The survey was conducted on the island of Tutuila at two different regions - the east and the central regions. The villages sampled in the east region were from Utumea to Lauli'i. In the central region, villages sampled were Faga'alu, Fatumafuti, Matu'u, Faganeanea, Avau and Nu'uuli (Fig. 3).

### 2.2. Sampling Protocol

The sampling protocol is similar to the protocol adopted for the inshore creel survey (see Ponwith, 1992). During the expected palolo nights, the Central and East regions were divided in several portions according to the number of teams and vehicle that were available. Each survey team drove the road adjacent to the coastline in their respective survey area. Sampling occurred every hour, on the hour. Participation data recorded the number of individuals present and observation time at each site. The number of people was categorized into three groups – the number of people fishing with gear, the number of assistants and the number of individuals waiting from the shoreline. Only the former two groups have been considered as participants.

In addition, interviews were conducted at each site. The interview questioned for how long the participant had been fishing, the type of fishing gear being used, how many people were assisting, whether or not the catch will be for sale and the total weight of the catch. The quantity of the catch was weighed and recorded by the interviewer.



**Figure 2: Tutuila Palolo Survey Routes**

- Eastern Region (2001 & 2002)
- Central Region (1990-1991-2001-2002)
- Tutuila main roads

Produced by WB White (DMVR Fisheries Division). July 2003.

## 2.3 Analysis

For each fishing party sampled, the trip length was multiplied by the number of people in the fishing party (fishermen and assistants who hold flashlights and buckets) to obtain a number of person hours of effort<sup>1</sup>. The party's catch was divided by the number of person hours to derive the CPUE (kg per person hour). A mean CPUE was calculated by dividing the sum of each trip's CPUE by the total number of trips. Mean CPUE was then multiplied by the total number of people participating to get total harvest.

## 3. RESULTS

### 3.1. 2001 Palolo event

In 2001, the full moon appeared at the beginning of the month on the 2<sup>nd</sup> October. This early occurrence was a possible contribution to the unsuccessful swarming of the palolo in October, thus there was no survey. However, the palolo survey was conducted in November to determine the value of the catch per unit effort for palolo harvesting through participation counts and interviews. The swarming occurred on the evenings of the 7<sup>th</sup> and 8<sup>th</sup> of November but stronger on the night of the 8<sup>th</sup>.

The survey began at approximately 10:30 pm and lasted until approximately 3:30 am the next morning. On the first night, the 7<sup>th</sup> of November, two runs were completed starting from the Eastern side villages working towards the central region. A team drove through the village sites and collected participation counts of individuals present at a particular site either fishing, assisting or just witnessing the palolo fishing event. On the second night, the 8<sup>th</sup> of November the staff members were assigned to each region. There were two staff members assigned to the Eastern region and two to the Central

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<sup>1</sup> Interviews done in 2001 should be taken with caution. The fishing durations provided by fishermen appeared less accurate and uncertain. In order to estimate the CPUE, we have used the average time obtained in 2002 interviews: 1 hr 28 min ( $\pm$  18 min). Furthermore, this time seems to correspond to the average swarming duration of Palolo.

region. A vehicle “run” was performed on the hour at every hour through the chosen villages in each of the regions.

From the two regions, the highest total number of participants was found in the village of Matu'u (242) in the central region (Table 1, Fig. 3) whereas the maximum in the Eastern region was 92 participants in Alega. In addition, the total participation was higher on the second night (November 8<sup>th</sup>) than during the first (November 7<sup>th</sup>). In the four villages that were surveyed on both nights (Avaio – Alega – Lau'i'i – Fatuma Futi), an increase in participants was observed on the second night compared to the first night (table 1).

Fourteen teams, which corresponded to 49 participants, were interviewed during the 8<sup>th</sup> of November 2001 (Table 2). The total catch was 15.1 kg (33.2 lb), and the estimated CPUE: 0.18 ± 0.12 kg per participant per hour (0.39 ± 0.27 lb per participant per hour).

After extrapolation of these data to all sampled villages, the total palolo harvest for the night of 8<sup>th</sup> November 2001 was 172 kg (379 lb).

All the teams responded that Palolo was for their own consumption.

Table 1: Number of participants (fishermen and assistants) per village sampled during palolo events in 2001 and 2002

	2001		2002	
	7-Nov	8-Nov	26-Oct	27-Oct
Utumea	n/a	5	5	0
Alofau	n/a	0	1	27
Faga'itua	n/a	8	68	37
Amaua	n/a	4	22	284
Auto	n/a	73	16	135
Avaio	7	30	0	0
Alega	28	92	0	245
Aumi	n/a	10	5	0
Lau'i'i	20	32	12	31
Faga'alu	n/a	69	8	6
Fatumafuti	18	60	0	434
Matu'u	n/a	242	3	933
Faganeanea	n/a	198	0	9
Avau	n/a	106	4	8
Nuu'uli	n/a	48	4	6
<b>TOTAL</b>	<b>73</b>	<b>977</b>	<b>148</b>	<b>2,155</b>

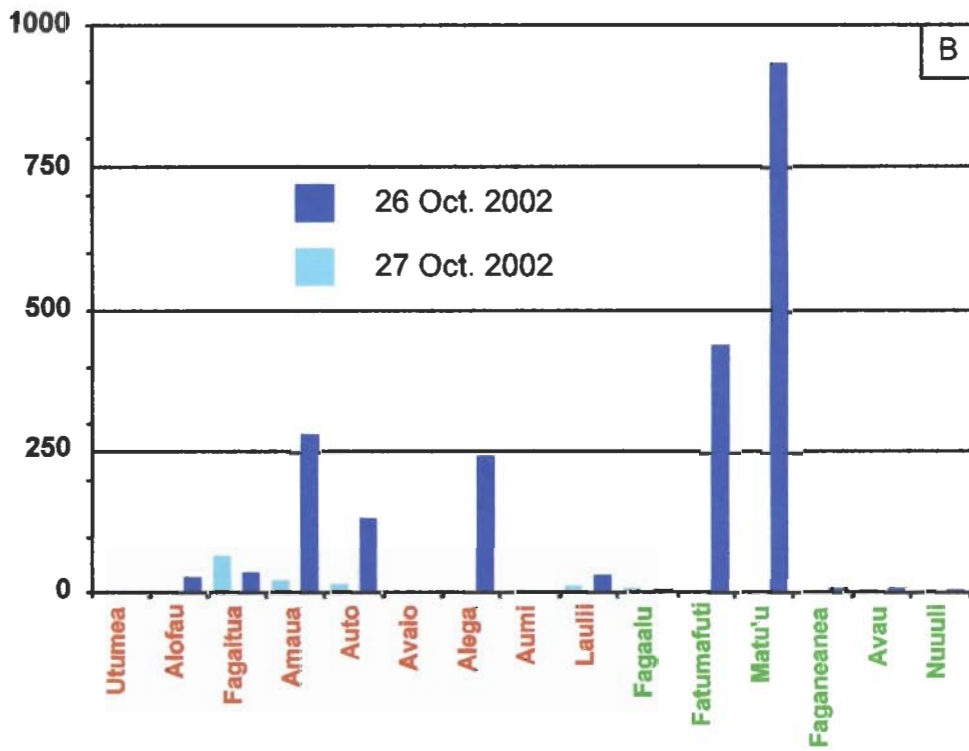
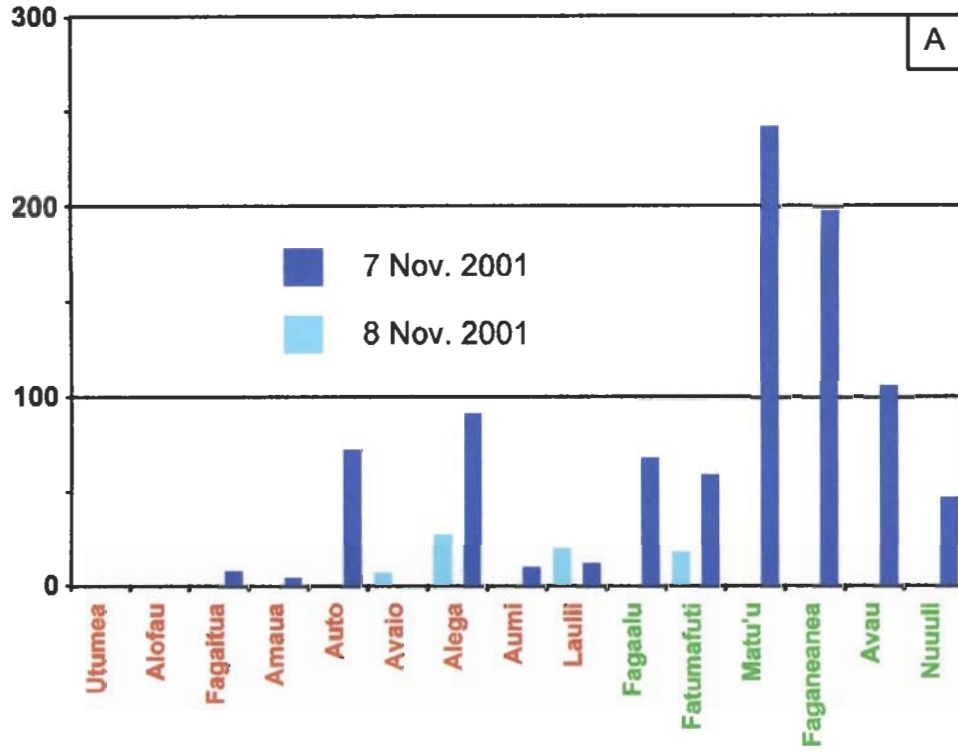


Figure 3: Number of participants (fishermen and assistants) per village during palolo events

A: in 2001; B: in 2002

### 3.2. 2002 Palolo event

In 2002, Palolo swarming occurred during nights of the 26<sup>th</sup> and 27<sup>th</sup> of October exactly seven days after the full moon. The East and the Central regions were assigned to 2 teams. Surveys were done from approximately 10:30 pm to 2:30 am. For each night, 2 'runs' were first made in order to estimate the number of participants, and then interviews were conducted.

During the first night (26<sup>th</sup> October 2002), there was no palolo caught but a total of 604 people were present along the coastline. From this total, 148 individuals seemed to be fishermen or assistants. On the 27<sup>th</sup> of October, 2,986 people (2,163 estimated fishermen or assistants) have been counted, with a maximum of 933 in Matu'u (Table 1, Fig. 3). The 36 interviewees were asked if their catch was to be sold and all of them responded that their catch was not going to be sold.

Results from interviews carried out in 2001 & 2002 was summarized in table 2.

Table 2: Total results obtained during palolo survey in 2001 and 2002.

	<b>2001</b>	<b>2002</b>
Number of interviews	<b>14</b>	<b>36</b>
Number of Participants	<b>49</b>	<b>117</b>
Number of Participants per team	<b>3.50</b> [ 1 fisherman + 2.50 assistants	<b>3.25</b> [ 1.02 fisherman + 2.22 assistants
Total Catch in kg (& in ib)	<b>15.08 (33.25)</b>	<b>88.28 (194.62)</b>
Average CPUE	<b>0.18 ± 0.12 (SD = 0.17)</b>	<b>0.64 ± 0.51 (SD = 0.86)</b>
Catch in kg (& in ib) per Participant per Hour (α = 0.01)	<b>0.39 ± 0.27 (SD = 0.37)</b>	<b>1.41 ± 1.12 (SD = 1.90)</b>
Total number of Participants in village sampled	<b>977</b>	<b>2,155</b>
Total harvest for all village sampled in kg (& in ib)	<b>172 (379)</b>	<b>1,386 (3,055)</b>

After extrapolation to the sampling area, the total palolo harvest for the night of 27<sup>th</sup> October 2002 was 1,384 kg (3,050 lbs).

### **Additional data**

In 2002 Palolo swarming was surveyed by the National Park of American Samoa staff in Ofu (Manu'a archipelago – American Samoa). Palolo were abundant during two nights: the 27<sup>th</sup> and 28<sup>th</sup> of October. The total number of participants was about 235, and the total catch was calculated to be 953 kg (2,100 lbs).

## **4. DISCUSSION**

Although the sampling effort was not equal in both years, results show that the harvest has been more important in 2002 than in 2001. Several factors can influence the palolo harvest, and variations occurred year after year. Ponwith (1992) used the same methodology to estimate the total palolo harvest in 1990 and 1991 but for a smaller area, between Faga'alu and Nu'u'uli. As our sampling area included these villages, it is possible to re-calculate effort, CPUE and total harvest only for this region in order to compare with 1990 and 1991's results (table 3).

Palolo catches appear to vary from year to year, with no clear trends. In the same way, the number of participants varies a lot, without correlation with the success of the harvest.

Ponwith (1992) indicated: "*Harvest success, according to anecdotal information, is dependant on the strength of the swarming event and the presence of offshore winds that concentrate the epitokes near the shoreline, making them more accessible to the fishermen*". Furthermore, although there is a peak of swarming during a night, part of the Palolo population spawn around this special night, and even in previous or next lunar period (see Introduction: *Rules for predicting Emergence*).

Thus, Palolo survey should be a long term study to assess catch variations through out the years on Tutuila Island in order to find trends and to prevent potential over-fishing.

Table 3: Comparison between results obtained during palolo surveys in 1991-1992-2001 and 2002 expanded to the sampling area. For the two latter, data (participation and interview) from villages situated between Faga'alu and Nu'uuli have only been used.

Year	Participants between Faga'alu and Nu'uuli	Catch		CPUE
		in kg (in lb)	in kg (in lb)	.participant <sup>-1</sup> .hr <sup>-1</sup>
1990	764	1,552	(3,446)	0.91 (2.0)
1991	1,463	270	(600)	0.09 (0.2)
2001	723	259	(535)	0.36 (0.7)
2002	1,396	745	(1,642)	0.53 (1.2)

## 5. Recommendations

In order to improve the strategies for our survey, we have developed recommendations that we would like to use for enhancement of the study. These recommendations are as follows:

- To work on the survey, we need a minimum of 2 teams in the east part and 2 in the Central, (3 would be preferable since the effort appears more important in this region);
- All DMWR staff recruited for the survey must be informed of the exact purpose of the study: why and how do they drive along the coastline?; why and how do they interview fishermen?;
- New Palolo harvest forms must be developed. Each team must have a pre-printed form for each village and for each run. The form should also include wind valuation;
- The radio and newspaper must be informed that DMWR staff will be surveying in the field during palolo nights;

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## Photo

- Figure 1 A; 2 A-B: Smithsonian National Museum of Natural History  
[http://web8.si.edu/nmnh/palola/opt/fig4\\_worm\\_hr.jpg](http://web8.si.edu/nmnh/palola/opt/fig4_worm_hr.jpg)
- Figure 1 C; 2 C: Dr Peter Craig – National Park of American Samoa  
[http://www.nps.gov/npsa/book/11\\_palolo.htm](http://www.nps.gov/npsa/book/11_palolo.htm)

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