



## Costly signaling and torch fishing on Ifaluk atoll

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### Abstract

In this paper I evaluate the merit of costly signaling theory (CST) as a paradigm for understanding why men of Ifaluk atoll torch fish. I argue that torch fishing is a handicap that signals men's productivity. Consistent with CST, torch fishing is observed by the predicted audience (women), energetically costly to perform, and a reliable indicator of the frequency a man fishes during the trade wind season. Contrary to expectations of who should benefit from torch fishing and consequently participate, torch fishers are not primarily young and unmarried. Torch fishers, however, are predominately from the matriline that owns the canoe on which they fish, suggesting that torch fishing also signals the productivity of a matriline. Although these results support the possibility that torch fishing is a handicap, no data are presented which demonstrate that torch fishers achieve any gains from sending the costly signal. This shortcoming and other directions for future research on Ifaluk foraging decisions are discussed. © 2000 Elsevier Science Inc. All rights reserved.

*Keywords:* Costly signaling theory; Foraging decisions; Micronesia

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This paper will explore why men of Ifaluk atoll torch fish. This issue was raised by research that examined patch choice decisions among Ifaluk fishers. In this work, it was shown that torch fishing for dogtoothed tuna is a poor foraging choice if a fisher's goal is to maximize the rate at which he acquires resources (Sosis, submitted a, submitted b). On Ifaluk, the yellowfin tuna patch is, on average, more profitable than the dogtoothed tuna patch, and it is generally more profitable even on days that fishers exploit the dogtoothed tuna patch. It also was shown that the consumption rates<sup>1</sup> of fishers are higher when they troll for yellowfin tuna than when they torch fish for dogtoothed tuna. This is especially evident for canoe owners, who on average achieve trolling consumption rates more than four times as high as their torch fishing consumption rates. Why then would men ever choose to torch fish? To address

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<sup>1</sup> Consumption rates were calculated as the weight (kg) of fish a fisher consumed following a fishing event per hour that he spent fishing.

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this question, I will explore an argument proposed by Smith and Bird (2000), who used costly signaling theory (CST) to explain why Meriam islanders hunt for turtles. Heeding their call to find other possible examples of costly display among human foragers, I will evaluate whether CST can explain why Ifaluk men torch fish.

## 1. Costly signaling theory

### 1.1. *Honest signals*

Since selection is competitive and organisms rarely have identical interests, signals and displays are assumed to convey information and influence others in a manner that will benefit the sender but not necessarily the recipients of the signal (Dawkins and Krebs, 1978; Krebs and Dawkins, 1984). Organisms often can gain the most benefits by sending deceptive signals that suggest they are bigger, better, and more powerful than they really are. Thus, it is puzzling that organisms ever use the information conveyed in signals and displays, since the temptation to deceive may limit the frequency of accurate and honest signals in a population. An honest signal can be considered a cooperative act, and as such it requires a mechanism to evolve that can limit defection (i.e., sending a dishonest signal; Dugatkin et al., 1992; Messterton-Gibbons and Dugatkin, 1992). Biologists have posited two pathways through which an honest signal could emerge and subsequently achieve stability. First, a signal may be honest if it is directly linked to the quality of the trait that is being advertised. When variation in the trait is directly linked to variation in the advertisement of the trait, there is no possibility that others can imitate the signal (Johnstone, 1997). Second, an honest signal may be evolutionarily stable if it is a handicap (Zahavi, 1975, 1977a; Grafen, 1990). The handicap principle states that an honest signal can be stable if it is so costly to produce that lower-quality organisms would not benefit by imitating the signal. Costly signals can communicate honest information about a trait when imitating the signal is more costly for those who do not possess the trait being advertised, and these higher costs ensure that imitating the signal will not be profitable. The handicap principle also could explain the evolution of an honest signal when organisms face similar signaling costs, if these costs are high enough that only those who are sending honest signals can benefit (Johnstone, 1997; Smith and Bird, 2000).

Smith and Bird (2000) suggest four characteristics that behavioral traits<sup>2</sup> should exhibit if they are an evolutionarily stable handicap. First, to be a signal the behavior must be *observable*.<sup>3</sup> The size of the audience will vary (and could be as small as one) depending on the ecological conditions and the gains that can be achieved. Second, the behavior must be *costly*, otherwise it could be easily imitated. Third, the behavior must be a *reliable* indicator of the trait being advertised. In other words, variation in the signal must be correlated with variation in the quality of the trait being advertised. Fourth, although the behavior must be costly, it

<sup>2</sup> CST also has broad implications for morphological displays (e.g., Moller and de Lope, 1995).

<sup>3</sup> This does not imply that a signal must be observed by an organism to have an effect on that organism's behavior. Reputations enable human signals to reach a wider audience than just the observers of the signal. Nonetheless, someone must observe the signal.

must also confer some *benefit* on the actor/sender. These benefits must outweigh the costs that the organism paid to send the signal.

### 1.2. *Is torch fishing a handicap?*

If torch fishing is a handicap, there must be some benefit for broadcasting the display. Smith and Bird (2000) have suggested that better turtle hunters on Mer should “be favored as mates, deferred to in competitive contexts, or have larger circles of allies.” Here I will explore the first of these suggestions and argue that torch fishing is a costly display that advertises a man’s work ethic. On Ifaluk, women (and men) invariably claim that they are looking for a hard-working mate. Parents also discourage their daughters from considering mates who have a reputation for indolence. The distinct sexual division of labor on Ifaluk (only men fish and only women harvest taro) may explain why industriousness is such a highly valued characteristic in a mate. The protein and lipids available to a woman and her offspring are directly related to the productivity of her brothers, father, and husband. Thus, her choice of a husband is her primary means through which she can influence the amount of fish consumed by her family. However, the sexual division of labor also creates an information problem for women. How do they know if a potential mate is assiduous? Men and women spend most of their day separate from each other; women in the taro field or compound, men fishing or in the canoe house. This separation is enhanced by rules that prohibit men from entering the taro patches and women from entering the men’s houses, and taboos that discourage conversation and contact between men and women during the day (Burrows and Spiro, 1957). Women rarely observe men’s primary production activities, fishing and palm sap collecting. Women could learn of a prospective mate’s productivity via her male kin, although such reports may be unreliable due to conflicts of interest men face between achieving fitness benefits via female kin and political allies. Here I will argue that torch fishing provides women with reliable information on the otherwise unobservable work ethic of a prospective mate. I will examine whether torch fishing exhibits the four characteristics of an honest handicap (observable, costly, reliable, and beneficial) suggested by Smith and Bird (2000).

## 2. **Ethnographic background**

Ifaluk is a coral atoll located in Yap State in the Caroline Islands of the Federated States of Micronesia at 7°15′ north latitude and 147° east longitude. The nearest inhabited atoll is Woleai at 53 km west of Ifaluk, and Yap, the largest island in Yap State is located about 560 km northwest of Ifaluk. Ifaluk consists of four atolls, two of which are inhabited. The total landmass of the four atolls is 1.48 km<sup>2</sup> and the nearly circular lagoon is 2.43 km<sup>2</sup> (Freeman, 1951:237–238, 273–274). The two inhabited atolls, Falalop and Falachig, are separated by a 35-meter channel that is less than a meter deep during high tide and completely dry during low tide. The channel can easily be crossed on foot even during high tide. It is estimated that Ifaluk receives between 254 and 305 cm of rain per year (Tracey et al., 1961). Daily temperatures range from 21 to 35°C and remain nearly constant throughout the year. The two seasons on Ifaluk are differentiated by the presence of northeast trade winds from October through May.

There are four villages on Ifaluk, two on each inhabited atoll. Villages consist of 5 to 13

*matrilocal* compounds. The 36 total compounds on Ifaluk range in size from 1 to 4 houses and 3 to 35 residents. Houses are composed of either nuclear or extended families. There are seven ranked matriclans on Ifaluk; the five highest are chiefly clans (Sosis, 1997). Clans are not localized, and members of each clan can be found in all four villages. The observational data presented in this paper were collected on Falalop atoll from December 1994 to April 1995. Of the 189 individuals who lived on Falalop during the 1994–1995 field session, 99 resided in Iyeur village and 90 resided in Iyefang village.

### 2.1. Subsistence

Ifaluk primarily maintains a subsistence economy. The diet largely consists of pelagic and reef fish, taro, breadfruit, and coconut. Pigs, chickens, and dogs are raised for consumption and usually only prepared for bimonthly feasts. A store is maintained on each of the inhabited atolls that offers flour, rice, and other assorted goods. White rice is the most frequently purchased food product, although not all residents can afford it (the overwhelming majority of residents do not have an income; see later). There is no refrigeration on Ifaluk. Fish occasionally are smoked, but competition with the dogs, cats, and rats makes long-term storage difficult. For a more detailed description of subsistence on Ifaluk, see Sosis (1997).

As throughout the Pacific, the palm tree seemingly has unlimited uses on Ifaluk. With regard to subsistence, copra often is eaten raw or cooked with breadfruit or taro. In addition, palm sap is collected daily for the children and, when permitted by the chiefs, is fermented and consumed as an alcoholic beverage by the men. Men collect palm sap by cutting a flower stalk and tying a carved-out coconut shell to the end of the branch. Men cut their palm trees two to three times each day to stimulate the flow of the sap. If a tree remains uncut for a day, it takes several months for the tree to regain a constant flow of sap.

Fishing is the primary means of protein acquisition on Ifaluk. Only males participate in fishing activities. Fishing methods differ significantly by season. Here I will focus on fishing methods observed during the trade wind season (October–May). There are five fishing patches exploited during the trade wind season, four of which are exploited by unique fishing methods. All fishing methods are mutually exclusive and no patches were ever exploited simultaneously by different groups of men (e.g., no one ever fished solitarily while others trolled). Here I describe each fishing method and the unique patch that the method exploits.

#### 2.1.1. Morning trolling<sup>4</sup>

Most mornings (72%;  $n = 114$  observation days) before dawn during the trade wind season, males congregate at the central canoe hut on Falalop to prepare for fishing. There are four large sailing canoes on Falalop; each canoe is owned and maintained by a specific matriline and, hence, compound. After the canoes are prepared, all the males who are present help to push each canoe that will be sailing that morning into the lagoon. Each compound is historically associated with a particular canoe, and males generally troll on the canoe that is

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<sup>4</sup> Previous publications referred to this fishing method as “cooperative sail-fishing” (Sosis et al., 1998; Sosis 2000). This name will not be used in this article because it would only confuse readers; torch fishing is cooperative and also utilizes a sailing canoe. Here I will refer to this fishing method as morning trolling or trolling for yellow-fin tuna, which are more accurate descriptions.

associated with the compound where they were raised (Sosis et al., 1998). The canoes then will sail outside the reef and troll primarily for yellowfin tuna, which accounted for 89% of the morning trolling harvest by weight during the observation period ( $n = 114$  days). Upon return, men throw their catch into a pile that is distributed by a divider after all the canoes have returned (Sosis, 2000). During a 98-day observation period<sup>5</sup> of all fishing methods, morning trolling provided nearly 88% by weight of all fish caught.

### 2.1.2. 9-Mile reef fishing

Men occasionally fish at a reef located 9 miles west of Ifaluk, appropriately known as 9-mile reef.<sup>6</sup> Men travel on the large sailing canoes to 9-mile reef in order to troll for yellowfin tuna, although if the conditions upon arrival are not appropriate for trolling they also pursue reef fish. To reach 9-mile reef before dawn, men depart on their 5- to 7-hour journey at about 10:00 in the evening. They return from the fishing trip in mid-afternoon the following day and are greeted by an atoll-wide feast.<sup>7</sup> During the observation period, men only fished at 9-mile reef twice, and their returns from these events account for less than 1% of all fish harvested during this period.

### 2.1.3. Solitary fishing

All solitary fishing methods exploit reef fish in Ifaluk's lagoon. During the observation period ( $n = 98$  days), solitary fishing resulted in the capture of 62 different species of reef fish. The main type of solitary fishing during the trade wind season is line fishing with bait. Octopus and land crabs are used most frequently as bait. Almost all males over 15 years old own the solitary outrigger canoes used for line fishing. Spear and trap fishing also were observed during the trade wind season (for a description, see Burrows and Spiro, 1957). During the observation period, only 15 of 45 males who stored their outrigger canoes on Falalop engaged in any form of solitary fishing, and their returns account for only 2.2% of the fish caught during this period.<sup>8</sup>

<sup>5</sup> Data were collected on all fishing methods on 98 days during the field session. These data are nearly complete (see Methods); therefore, most analyses presented here were conducted using these data. Data also were collected on some fishing activities for an additional 16 days (or 114 total observation days), although data were not collected on solitary fishing during this period, and starting and ending times for morning trolling were not collected.

<sup>6</sup> 9-Mile reef was known as Fes in Woleaian, the primary language spoken on Ifaluk (cf. Burrows and Spiro, 1957).

<sup>7</sup> I have previously suggested that 9-mile reef fishing also may be a costly signal (Sosis, submitted a). Unfortunately, only two events were observed during the 1994–1995 field session, so it is difficult to draw any conclusions. If 9-mile reef fishing is a costly signal, it appears to share several characteristics with turtle hunting on Mer (Smith and Bird, 2000). The physical costs of 9-mile reef fishing are demanding. Burrows and Spiro (1957) estimate that 100 pounds of fish were caught during the one event they observed, yet they still comment that it was “hardly worth the effort of the long trip” (p. 106). Fishers spent 15.8 and 19.5 hours fishing during the two 9-mile reef events I observed, and the returns from these two events were very low, 22.4 and 0 kg, respectively. While the men were fishing, the women from each compound on Falalop prepared bowls of taro and breadfruit for a feast. However, on each occasion, men did not catch enough fish to be widely distributed as is typically done during feasts. 9-Mile reef fishers also engage in costly ceremonial and ritual behavior, but not to the same extent as torch fishers (see below and Burrows and Spiro, 1957).

<sup>8</sup> These data refer to daytime solitary fishing. I did not collect systematic data on nighttime solitary fishing activities. However, casual discussions about solitary fishing indicate that (1) nighttime solitary fishing occurred less frequently than daytime solitary fishing, and (2) no individual exclusively fished at night.

#### 2.1.4. Rope fishing

Rope fishing also occurs in Ifaluk's lagoon. Rope fishing is an atoll-wide event; that is, all men who reside on the atoll are expected to participate. Preparations take roughly 2 hours and commence after the men complete their morning rounds of cutting palm sap. Rope fishing utilizes two ropes that are each over 50 meters long. Preparations mainly consist of collecting coconut fronds that are tied to these long ropes. The elders of the community lead the fishing party in two or three middle-sized paddling canoes. On 20 to 25 solitary outrigger canoes, the rest of the men travel to the fishing site where the elders will organize all of the canoes into a circle. The two ropes are tied together and passed along to each of the canoes. A fishing net is secured in the center of the circle. Most of the men proceed into the water, while a few remain above to watch the canoes. Wearing diving masks, men place the rope on the lagoon floor and, swimming slowly and in synchrony, move the rope toward the fishing net. The coconut frond-covered rope is intended to frighten and hence drive the fish toward the net. When the circle created by the men becomes small, the men scream and splash, making a great commotion to chase the fish into the net. The nets then are emptied into the canoes of the elders. This process is repeated four to five times at different locations in the lagoon. The fish are placed in a communal pile and divided among the residents of the atoll. Only two rope fishing events occurred during the observation period, and the returns from these events account for only 3.3% of the fish harvested during this time.

#### 2.1.5. Torch fishing

In addition to morning trolling and 9-mile reef fishing, men also use large sailing canoes to torch fish for dogtoothed tuna. Torch fishing occurs in two stages. First, torch fishers catch flying fish in small hand nets roughly 2 feet in diameter. Men use torches made from dried coconut fronds to attract the flying fish to the sailing canoe. In the second stage, the flying fish are used as bait for deepwater trolling to catch large dogtoothed tuna [80% by weight of all fish caught torch fishing were dogtoothed tuna ( $n = 114$  observation days)].

Torch fishing is the most ritualized fishing method on Ifaluk. Men must prepare for several weeks before they can torch fish. Preparations primarily consist of collecting and drying coconut fronds that they will wrap tightly together and use as torches. Around the time of each new moon, the magician<sup>9</sup> determines whether the cycle of the moon is favorable for torch fishing. If it is deemed propitious, those canoes that are prepared may fish. The first evening that a canoe is allowed to torch fish during a cycle is referred to as an *entry day*. Only males that fish on the entry day may fish for the remainder of the moon's cycle. Males who do not fish on the entry day must wait until the following cycle to participate.

In the late afternoon of a day men expect to torch fish, the leaders of the canoe (the captain and elders of the matriline that owns the canoe) consult with the magician to determine the most auspicious location to fish. When the sun sets, the men depart on their sailing canoes in ritualized fashion. First, a fire is set on the beach. The canoes that will sail are pushed into the lagoon and the men carry the torches through a shallow area of the lagoon to the sailing canoe in a single file line. Women and children often spend the early part of the evening on the shore watching the canoes. The light of the flames against the large white sails in the open sea is a

<sup>9</sup> See Burrows and Spiro (1957) for an excellent description of the role of the magician in Ifaluk society.

spectacular sight. The canoes return when the moon rises; thus, as the month progresses, men are able to fish for longer and longer each evening until a new moon appears.

After the first night of fishing, all of the men who fished that evening are expected to be at the canoe house at dusk for the duration of the moon's cycle. At the canoe house it is decided who will fish that evening. Those men who will not be fishing that evening help to push the canoe into the lagoon and carry the torches out to the canoe. Informants claimed that a minimum of six men were needed to torch fish, but that eight was the ideal number: four men to hold the fishing nets, one man to hold the torch, one man to steer the canoe, and ideally two additional men to move the sail. Data on the number of men per canoe indicate that canoes never sailed with less than six fishermen, and on only three occasions canoes sailed with more than eight men (Sosis, submitted a). Two of these three occasions were entry days, when it is necessary to include everyone who has participated in preparations (see later) so that they will be allowed to fish in the following weeks. For example, on the first evening of the torch fishing season, 14 men crowded into one canoe.

During the 1995 trade wind season, men torch fished on 13 evenings. The first torch fishing event occurred on February 18 and the last was on March 23, with entry days on February 18, February 28, and March 23.<sup>10</sup> Men who did not torch fish on February 18 could not torch fish until February 28, and those who did not fish on February 28 had to wait until March 23. During the first cycle of the moon, only one canoe fished and they were joined by another canoe during the second cycle. Fish captured during torch fishing account for less than 5% of the total amount of fish caught during the observation period (Sosis, 1997). Torch fishing harvests are the property of the compound (matriline) that owns the canoe on which the fish were caught. The canoe-owning compound subsequently redistributes fish to the fishermen who do not reside in the compound, although most of the fish remain within the canoe-owning compound (Sosis, submitted b).

### 3. Methods

Observational data on all fishing activities were collected daily on Falalop atoll from December 19, 1994 to April 5, 1995, with the exception of 9 days in March (March 4–12;  $n = 98$  days). In order to collect data on trolling activities, every morning during the observation period I observed and recorded (1) which of the canoes set sail, (2) names of the fishermen on each canoe, (3) time of departure and return for each canoe, (4) weight and species of each fish caught by canoe, and (5) where each fish was distributed. Data on torch, rope, and 9-mile reef fishing were collected opportunistically. These fishing events were easily monitored, because they were public events and widely discussed before occurring. Data collection during these events was identical to the methods just described. The data set on these fishing activities during the observation period is complete; no fishing events were missed and no data were missed during any event.

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<sup>10</sup> It is not clear whether the magician did not permit men to torch fish on the potential entry day between February 28 and March 23, or whether the men simply chose not to torch fish on this day. Regardless, it is unlikely that the magician makes his decisions independently of the desires of the fishers.

Solitary fishing activities occurred in the lagoon and thus were easily monitored due to the high visibility of the activity. Observation days were spent at one or several of the Falalop canoe houses that line the shore of the lagoon. All solitary fishing activities commenced from one of these canoe houses. Data collection activities that required me to leave the shoreline never caused me to lose sight of the lagoon for more than one-half hour. For each solitary fishing event, I recorded the (1) name of the solitary fisherman, (2) time of departure and return, and (3) weight and species of all fish caught. Of 57 total solitary fishing events during the observation period, data were missed (specifically, time of departure) during only three events. Data were not collected on men who stored their outrigger canoe on Falachig, since departures from Falachig could not be efficiently monitored.

Data also were collected to estimate the amount of time men spend preparing for torch fishing. With the exception of collecting the palm fronds used to make torches, most preparatory activities for torch fishing occur in the main canoe house. Hourly spot observations (10:00–17:00) were conducted at the main canoe house for 10 continuous days, from February 20 to March 2. During these observations, I recorded the (1) names of all men in the canoe house actively engaging in torch fishing preparations, and (2) the activity of each man. Spot observations were taken infrequently (once per hour) because of conflict with other data collection activities.

Data were collected on palm sap harvesting for 19 men from December 21, 1994 to April 4, 1995. Data were collected nearly daily, with the exception of 3 weeks in March when no data were collected. Most men cut their palm trees three times each day, but few men take any palm sap at the mid-day cutting. Focal follows were conducted in the morning and the evening, since men always brought sap to their families after these cutting events. Slips of paper with the names of the 19 men were placed in a bag, and one or two focal follows were chosen from the bag prior to each data collection event. Names were not replaced in the bag until everyone was chosen, although data also were collected opportunistically. If a man could not be found, another man was chosen. If during a focal follow men engaged in other activities, such as collecting palm fronds or meeting kin to consume alcohol, the time allocation data were not used in the analyses. Complete data for 172 palm sap focal follows were recorded. With the exception of three individuals, each man was observed a minimum of five morning and five evening events. I recorded the time a man departed and returned to his compound, number of trees he cut, location of each tree, and weight of the palm sap he collected. Interviews ( $n = 10$ ) of nonfocal individuals supplemented the data on the number of trees men cut and the location of those trees.

Eleven times during the observation period a boat brought residents to the atoll or departed with residents. Departures and arrivals of residents were always recorded and easily monitored, because the arrival or departure of any boat was always a public affair.

All statistical analyses were conducted using SAS (Cary, NC).

## 4. Results

### 4.1. *Is torch fishing observable?*

If torch fishing is a display, the intended audience must observe it. Torch fishing is indeed the most widely observed fishing activity on Ifaluk. As mentioned earlier, women and chil-



dren often spend the early part of the evening on the shoreline watching the canoes sail beyond the reef. While on the shore women invariably discuss who is in each canoe. Torch fishing is the only fishing method in which women are *not* discouraged from watching. When men are morning trolling or rope fishing, women are prohibited from entering the canoe house and discouraged from spending time on the shoreline. Indeed, even requests by my wife to take pictures of fishing activities from the shore were rejected by the chief.

Not only is torch fishing widely observed by women, but there are also ritual constraints that make broadcasting the display very effective and help to enhance torch fishers' unique status during the torch fishing season. Since men are only allowed to torch fish if they fished on an entry day, it is very clear to everyone on the atoll who is (and consequently, who is not) a torch fisher. Torch fishers are not allowed to eat in the afternoon if they expect to torch fish in the evening. On Ifaluk, whenever anyone passes by a compound they are greeted with a request: "Come and eat." Ritual constraints on eating in the afternoon remind others of a torch fisher's status. Torch fishers also are not allowed to eat certain foods such as taro baked in an underground oven. During the torch fishing season, torch fishers receive all of their meals at the canoe house. Informants claimed that in previous generations men lived entirely at the canoe house and were forbidden to return at all to their households during the torch fishing season (Burrows and Spiro, 1957). Obviously, this separation clearly distinguishes torch fishers from other men.

#### 4.2. *Is torch fishing costly?*

If torch fishing is a reliable signal of a man's work ethic, it must be costly enough that indolent men cannot participate (i.e., imitate the signal) or it would not be beneficial for indolent men to participate. Is torch fishing any costlier than the other fishing methods observed during the trade wind season? In what currency should costs be measured? Zahavi (1977b) argued that for a signal to be honest, the costs of producing the signal must depend on the quality of the trait being advertised. For example, advertising the ability to escape a predator should put the organism at increased risk of capture [e.g., stotting among gazelles (Zahavi and Zahavi, 1997)]. If torch fishing advertises a man's work ethic, the appropriate currency to consider is some measure of time or energy expended torch fishing.

Table 1 presents the mean amount of time men spent fishing per event for each fishing method (9-mile reef fishing was excluded, see note 7). Fishers do not spend the same amount of time per event pursuing each method ( $n = 257$ ,  $F = 37.5$ ,  $df = 3$ ,  $p < .0001$ ). Duncan and Scheffe tests both indicate that men spend significantly more time torch fishing per event

Table 1  
Mean duration fishing per canoe event by fishing method

Fishing method	Number of events	Mean minutes fished per event ( <i>SD</i> )
Torch	17	301 (84.0)
Rope	2	213 (67.9)
Morning trolling	181	177 (48.1)
Solitary	57	140 (65.4)

than trolling or solitary fishing. The Duncan test also indicated a significant difference between torch and rope fishing, whereas Scheffe's test did not.

The most significant costs of torch fishing, however, are the preparations. Not only do men have to be organized and disciplined to complete the preparations prior to a new moon, the amount of time expended on the preparations also is remarkable. Approximately 3 weeks prior to the first torch fishing event during the 1995 trade wind season, men began to collect coconut fronds. During these weeks, literally hundreds of coconut fronds were brought to the shoreline and stored in various canoe houses. This is not energetically exhausting work (estimated at 158 kcal/hour for a 69.4-kg man; Sosis, 1997), but some men probably spent 1 to 2 hours per day collecting coconut fronds. Roughly 1 week prior to the first torch fishing event, men began making the torches. During this week, many men spent the afternoons at the main canoe house tying fronds together and wrapping them into a torch. In addition, several of the men made the hand nets used to catch flying fish. Once torch fishing commenced, men reduced the amount of time they spent collecting fronds and making torches, but it still was necessary to replenish their supply of torches. After the first entry day, data were collected on torch making activities over a 10-day period. Men who fished on the first evening spent an average of 40 minutes per day making torches ( $SD = 37$ ,  $n = 14$ ). These preparation activities are in addition to preparations that regularly occur prior to morning trolling, such as preparing hooks and lines, and removing fronds used as sun protection from the canoes. As a result of the significant time and energetic costs of preparation, men on average probably suffered a net caloric loss from torch fishing.<sup>11</sup>

Several customs enhance the cost of torch fishing. For example, men do not load the canoe while on the shore as is done during morning trolling. Instead, the canoe is pushed into the lagoon and is held by one or two men while the others carry the torches and fishing equipment through the water to the canoe. In addition to the caloric costs of many torch fishing rituals, potential gains are limited by a prohibition on the use of flying fish as bait during the first 4 days that a canoe is used during the torch fishing season. These flying fish may be consumed, but the total weight of flying fish caught per event never exceeded 2 kg during the observation period.

#### 4.3. *Is torch fishing a reliable signal?*

Does torch fishing convey reliable information about a man's productivity? Women should be concerned about the production activities of men that will provide resources for themselves, their future children, and their matriline with whom they reside. The main foraging activities of Ifaluk men are fishing and palm sap production. Let us first consider fishing.

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<sup>11</sup> Although I do not have empirical time allocation data on preparation activities over the full torch fishing season (several weeks prior to the first torch fishing event through the last event), some extremely conservative estimates suggest that, on average, torch fishing resulted in caloric losses for fishers. If men prepared on average for 46 minutes per day over 30 days at a cost of 158 kcal/hour, torch fishing would result in a caloric loss. On average, men probably spent much more time and energy than this preparing. Although elsewhere I have reported negative consumption rates for trolling and solitary fishing as a result of the fish sharing patterns (Sosis, 2000), this is the only fishing method (with the exception of 9-mile reef fishing; Burrows and Spiro, 1957; Sosis submitted a) that is likely to result in negative net production rates for participants.

Owing to their prominence in production, trolling for yellowfin tuna and solitary fishing should be particularly important for women. Previous work has shown that there is wide variance in trolling participation among men (see Fig. 2 in Sosis et al., 1998), and whether a man trolls for yellowfin tuna affects the amount of the catch that will be consumed by residents of the compound where he resides (Sosis, 2000). Morning trolling, which accounts for about 88% by weight of the total fish caught during the trade wind season, is replaced by solitary fishing as the primary means of protein acquisition during the summer. Fish caught through solitary means are not shared widely outside a man's residential compound (Sosis, 2000); thus, during the summer months, a man's solitary fishing productivity is likely to be highly correlated with his family's protein consumption, although empirical data demonstrating this currently are not available.

If torch fishing is a reliable signal of work ethic, torch fishing participation should predict fishing participation during the rest of the year. Here I only present data on fishing activities during the trade wind season. Men who are expected to fish on Falalop are *at risk* of fishing if they are on Ifaluk and there is a fishing event. The frequency that a man torch fishes when he is at risk of torch fishing (i.e., he is on Ifaluk and there is a torch fishing event) should be positively correlated with the frequency that a man pursues other fishing methods when he is on the atoll. Fig. 1 shows that the percentage of risk days that a man torch fishes is indeed positively correlated with the percentage of risk events that a man morning trolls, rope, 9-mile reef, and solitary fishes during the observation period ( $r = .78, p < .0001$ ).

Is torch fishing frequency an independent predictor of fishing participation during the trade wind season? The event that we are interested in modeling is whether or not an individ-

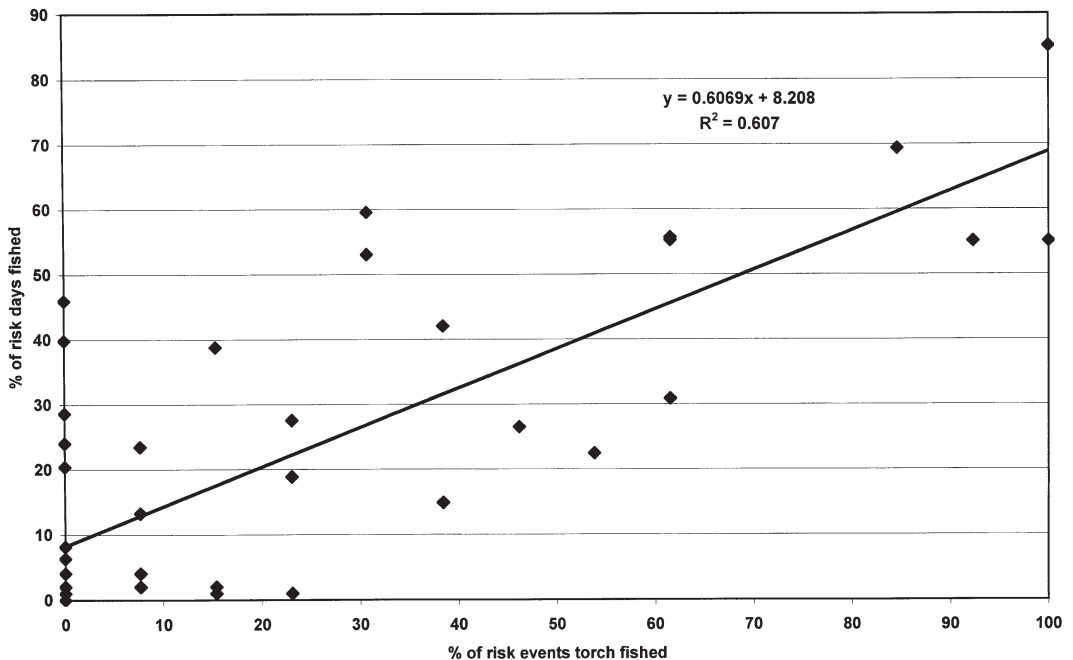


Fig. 1. Percentage of risk days a man trolled, rope, 9-mile reef, or solitary fished by the percentage of risk events that he torch fished ( $n = 45$  men).

ual fishes (trolls, rope, 9-mile reef, or solitary fishes) during the 98 observation days. The risk set consists of the number of men at risk of participating in a fishing event, by the number of observation days. There were 58 men at risk of torch fishing during the observation period. However, 13 men who did not store their solitary outrigger canoes on Falalop were not included in the risk set because data were not collected on their solitary fishing activities (see Methods). Over the observation period, the number of men at risk of fishing was never greater than 45 and changed 11 times as a result of individuals arriving at and departing from Ifaluk. The total risk set consists of 4,117 person days.

Since previous analyses have shown that age, educational status, marital status, and clan affiliation are significant predictors of trolling frequency (Sosis et al., 1998), it is important to determine if torch fishing frequency is an independent predictor of the frequency that other fishing methods are pursued. The results of logistic regression analyses presented in Table 2 show that controlling for these variables, torch fishing frequency is a significant predictor of the probability that a man fishes when he is at risk [see Table 3 for description of independent variables and Sosis et al. (1998) for additional details concerning data collection]. The univariate model is presented with two additional models. The first model includes the two independent variables for which data are not missing, age and marital status. The second model includes educational status and clan affiliation as covariates, both of which have missing data (notice the reduced  $n$ ), and marital status is dropped from the model. The percentage of risk events that a man torch fishes is not the only significant predictor of fishing frequency, and I am not arguing that women do not use criteria other than torch fishing to assess the productivity of a prospective mate. These results do suggest, however, that torch fishing is a reliable signal of a man's fishing effort.

Table 2

Logistic regression analyses of the probability of trolling, rope, 9-mile reef, or solitary fishing

Independent variable	Parameter estimate	Standard error	Partial $p$
–2 log likelihood for model covariates = 725.76; $p < .0001$ ; $df = 1$ , $n = 4117$			
Intercept	–2.2583	0.0606	
Percent of risk events a man torch fished	0.0326	0.0013	<.0001
–2 log likelihood for model covariates = 876.04; $p < .0001$ ; $df = 3$ , $n = 4117$			
Intercept	–0.6504	0.1415	
Percent of risk events a man torch fished	0.0268	0.0013	<.0001
Age	–0.0434	0.0043	<.0001
Marital status	0.1573	0.1063	0.139
–2 log likelihood for model covariates = 351.24; $p < .0001$ ; $df = 4$ , $n = 2279$			
Intercept	–1.1162	0.2088	
Percent of risk events a man torch fished	0.0194	0.0014	<.0001
Clan affiliation	0.1443	0.0277	<.0001
Educational status	–0.1616	0.0451	0.0003
Age	–0.0125	0.0045	0.006

Table 3  
Variables in regression analyses

Variable/Coding scheme	Mean	Standard Deviation	Minimum	Maximum	Sample size
1 Age	40.2	16.8	14	75	45
2 Marital status 0 = not currently married 1 = currently married	0.5	0.5	0	1	45
3 Clan affiliation 1 = highest ranking clan . . . 7 = lowest ranking clan	3.1	1.8	1	7	38*
4 Educational status 1 = highest educational status . . . 5 = lowest educational status	2.2	1.3	1	5	32 <sup>†</sup>
5 Percent of risk events a man torch fished	21.0	30.0	0	100	45
6 Average amount caught morning trolling, rope, 9-mile reef, and solitary fishing per day at risk (kg)	0.9	1.0	0	3.7	45
7 Average palm sap harvesting return rate (kg/hour)	3.3	1.3	1.6	5.5	17
8 Average amount of palm sap harvested per event (kg)	2.6	1.3	0.8	6.0	17
9 Number of trees cut	5.3	2.8	1	14	27

\*Data for some adopted males were coded as missing because it was unclear whether they were affiliated with their genetic mother's clan or their adopted mother's clan. Data from males suspected of endogamous marriage also were coded as missing. Owing to a cultural taboo against such marriages, responses by these males were considered unreliable (nobody ever claimed to be of the same clan as their spouse).

<sup>†</sup>Data on educational status is missing for 13 males.

When evaluating potential mates, women are likely to be more concerned about productivity than effort. Is torch fishing effort a reliable indicator of overall fishing productivity? The frequency that a man torch fishes when he is at risk of torch fishing should be positively correlated with the average amount of fish he caught per day that he was at risk of fishing. Fig. 2 shows that the percentage of risk events that a man torch fishes is indeed positively correlated with the average amount of fish he caught morning trolling, rope, 9-mile reef, and solitary fishing per day he was at risk of fishing ( $r = .76, p < .0001$ ).

Multiple regression analyses were conducted to evaluate whether torch fishing effort was an independent predictor of the average amount of fish caught morning trolling, rope, 9-mile reef, and solitary fishing per day at risk. The results are shown in Table 4. The dependent variable is the average amount of fish caught (kg) morning trolling, rope, 9-mile reef, and solitary fishing per day at risk. Analyses are similar to the logistic regression analyses presented in Table 2. The first model includes the two independent variables for which data are not missing, age and marital status. The second model includes educational status and clan affiliation as covariates, both of which have missing data (notice the reduced  $n$ ), and marital

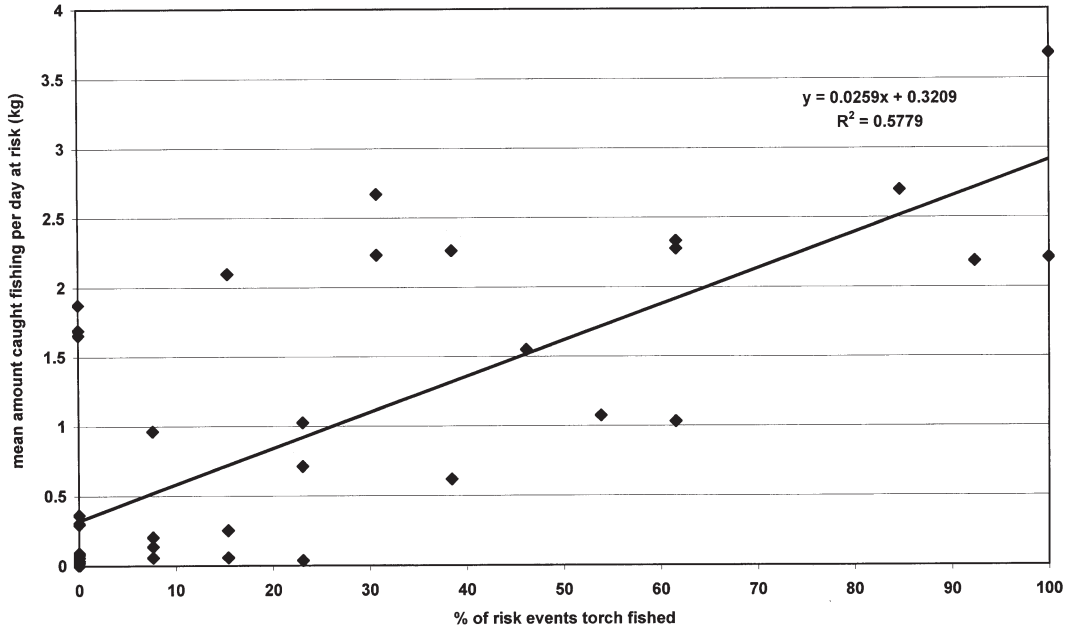


Fig. 2. Mean amount of fish caught morning trolling, rope, 9-mile reef, and solitary fishing per day at risk ( $n = 45$  men).

status, which is not significant in the first model, is dropped from second the model. The percentage of risk events that a man torch fishes is the only significant predictor of the average amount of fish caught per day at risk.<sup>12</sup>

Men cut palm sap for their children, and men without children cut palm sap for their nieces, nephews, or younger siblings. There is wide variation in the amount of palm sap a man harvests. Data from Falalop indicate that men cut between 1 and 14 trees each day, with relatively little change in the number of trees cut over the 5-month observation period. Palm sap is a high caloric drink in an otherwise low calorie diet (Bates and Abbott, 1958). Thus, it is critical for a woman to find a mate who will provide her children with a regular supply of palm sap. However, this information is not readily available. Without asking a man or his relatives how much palm sap he brings to his compound daily or how many trees he cuts, it is not obvious how a woman would know about a man's palm sap production. The amount that men bring to their households is dependent upon the number of trees they cut and the quality of those trees. If torch fishing is a reliable signal of work ethic, torch fishing frequency should be positively correlated with palm sap production.

The results of multiple regression analyses suggest that torch fishing frequency is not positively correlated with palm sap production.<sup>13</sup> Indeed, torch fishing frequency is negatively

<sup>12</sup> All analyses shown in Tables 2 and 4 were also conducted using the larger risk set ( $n = 58$  men) and eliminating all solitary fishing data. All results remained significant.

<sup>13</sup> Of the 19 men for whom palm sap collecting focal follow data were recorded, 17 were at risk of torch fishing.

Table 4

Multiple regression analyses of the mean amount of fish caught morning trolling, rope, 9-mile reef, and solitary fishing per day at risk

Independent variable	Parameter estimate	Standard error	<i>p</i> Value
Full model $F = 25.60$ , $df = 3$			
$r^2 = .652$			
$n = 45$			
Intercept	1.1647	0.3112	
Percent of risk events torch fished	0.0214	0.0035	<.0001
Age	-0.0158	0.0063	0.016
Marital status	-0.2209	0.1918	0.256
Full model $F = 6.47$ , $df = 4$			
$r^2 = .564$			
$n = 25$			
Intercept	1.3415	0.6783	
Percent of risk events torch fished	0.0173	0.0046	0.001
Age	-0.0152	0.0133	0.268
Clan affiliation	0.0766	0.0893	0.401
Educational status	-0.1127	0.1268	0.385

Dependent variable = mean amount of fish caught morning trolling, rope, 9-mile reef, and solitary fishing per day at risk (kg).

correlated with a man's average return rate of palm sap production ( $r = -.04$ ,  $p = .86$ ) and the average amount of palm sap that a man brings to his compound every day ( $r = -.45$ ,  $p = .08$ ). Torch fishing also is not significantly correlated with the number of trees that a man cuts ( $r = .14$ ,  $p = .47$ ). These results suggest that torch fishing is not a signal of a man's palm sap production.

#### 4.4. Do torch fishers receive benefits from torch fishing?

Longitudinal data on the mating patterns and reproductive success of Ifaluk men will be necessary to assess whether torch fishers benefit reproductively from torch fishing. Unfortunately, these data are not currently available. However, with the current data we can make several predictions concerning *who* should torch fish. If torch fishing is providing benefits as a costly signal, those that pursue this activity should be those who can benefit from it. If torch fishing is a signal of work ethic for potential mates, the senders of the signal should be predominately young unmarried men. Not only should young unmarried men benefit the most from torch fishing, their presumed larger energy budget and lack of a tradeoff with parenting effort makes them more capable of absorbing the time and energetic costs of torch fishing.

Table 5 presents the age, marital status, and torch fishing frequency of the 25 men who torch fished over the observation period. The mean and median ages of these men are 33.5 and 31 years, respectively (range 17–65). Torch fishers are significantly younger than the 33 men who were at risk of torch fishing, but did not (means = 33.5 vs. 44.2;  $t = 2.84$ ,  $df = 56$ ,  $p < .01$ ). However, torch fishers do not significantly differ in age from other fishers (Table 6).

The percentage of torch fishers who are married is significantly lower than the percentage of married men who were at risk of torch fishing (44% vs. 58%;  $n = 58$ ,  $\chi^2 = 3.62$ ,  $df = 1$ ,  $p =$

Table 5

Torch fishing frequency, age, marital status, and matriline affiliation of the 25 torch fishers ( $n = 13$  events)

	Torch fishing frequency	Age	Marital status	Matriline affiliation*
1	13	30	No	Yes
2	13	42	Yes	Yes
3	12	18	No	Yes
4	11	32	No	Yes
5	8	38	Yes	Yes
6	8	31	Yes	Yes
7	8	19	No	No
8	7	23	No	No
9	6	20	No	Yes
10	5	17	No	No
11	5	27	No	No
12	4	35	Yes	Yes
13	4	38	Yes	Yes
14	4	31	Yes	Yes
15	4	32	Yes	Yes
16	3	43	Yes	No
17	3	39	Yes	Yes
18	3	29	No	No
19	2	23	No	Yes
20	2	51	Yes	No
21	2	22	No	No
22	1	41	Yes	Yes
23	1	64	No	Yes
24	1	27	No	No
25	1	65	No	Yes

\*Did the man fish on the canoe of his (or his son's) matriline?

.057). The percentage of torch fishers who are married also is lower (although not significantly) than the percentage of married men who pursued all other fishing methods (Table 6). However, nearly half of the men who torch fished were married, which does not support the prediction that unmarried men predominantly pursue torch fishing. In other words, given the marital rates in the population, more unmarried men than would be expected by chance pursue torch fishing, but contrary to our prediction, nearly half (44%) of all torch fishers are married.

Table 6

Mean age, median age, and percent of fishers married by fishing method

Fishing method	Number of fishers	Mean age ( <i>SD</i> )	Median age	Percent married
Torch	25	33.5 (12.8)	31	44.0
Morning trolling	36	33.0 (12.0)	32	52.8
Rope	38	36.8 (13.3)	36.5	57.9
9-Mile reef	10	29.3 (8.4)	31.5	50.0
Solitary	15	34.3 (8.1)	35	66.7



## 5. Discussion

The results presented provide mixed support for the hypothesis that torch fishing is a costly signal of a man's work ethic. Torch fishing is clearly observed by the intended audience, costly to perform, and an honest and accurate signal of fishing effort and productivity. However, torch fishing does not operate as a signal of palm sap production, and men who choose to send the signal are not primarily young and unmarried, as was expected. In addition, I have not presented any evidence that the costs of torch fishing are outweighed by any benefits. Nevertheless, the results presented here raise several important questions as well as suggest directions for future research.

### 5.1. Why are older married men torch fishing?

The results presented indicate that torch fishers are no younger than men who troll or solitary fish, and nearly half of the men who torch fish are married. If torch fishing is so energetically expensive, how can these older men participate? Older men torch fished less than younger men; age is negatively correlated with torch fishing frequency ( $r = -.35$ ;  $p = .08$ ). The two torch fishers over 60 years old only fished once, and the one torch fisher over 50 years old only fished twice (Table 5). These men did not participate in the long hours of preparation, and their role while fishing consisted of advising or holding a fishing line, rather than the physically demanding tasks that the younger men were engaged in.

Nonetheless, it is curious that older married men torch fished at all. Especially puzzling is the case of one married man in his early 40s who fished during all 13 events. I have argued here that men torch fish to advertise their own work ethic. However, men's actions not only have consequences for their own status and reputation; their actions also affect the reputation of their matrilineage. It is possible that older men and married men are not paying the costs of torch fishing for their own personal mating gains, but for the mating gains that can be achieved by their younger matrilineal kin. By participating in torch fishing, older married men may be advertising that this is a hard-working matriline, and *everyone* in the matriline is hard-working. Whereas young men are advertising their own work ethic and marriageability, old men are advertising the work ethic of their matriline. If this interpretation is correct, older men should only torch fish if they are in the canoe-owning matriline, whereas young men should torch fish even if they are not in the canoe-owning matriline. Indeed, of the 14 torch fishers at least 31 years old, 12 (86%) were in the matriline (or had children in the matriline) that owned the canoe on which they fished. Of the 11 torch fishers under 31 years old, seven (64%) were not in the matriline that owned the canoe on which they fished. A chi-square test yielded significant results ( $\chi^2 = 6.51$ ,  $df = 1$ ,  $n = 25$ ,  $p = .01$ ).

Previous work has shown that the difference in consumption rates of torch fishing and morning trolling are much greater for men in a canoe-owning matriline than men who are not in a canoe-owning matriline (Sosis, submitted b).<sup>14</sup> In other words, although it is unclear why anyone would torch fish (unless torch fishing is a handicap), it is particularly puzzling

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<sup>14</sup> This is a result of the fish distribution patterns following morning trolling that preferentially reward canoe owners and their kin.

that members of a canoe-owning matriline torch fish. However, members of the matriline that owned the two canoes used during the torch fishing season were much more likely to torch fish than those who were not members of the matriline. Of the 20 men in these two matriline at risk of torch fishing, 16 (80%) torch fished. Of the four men who did not torch fish, one was over 40 years old and the other three were all over 50 years old. Although these men did not torch fish, they were all observed participating in preparations at the canoe house.

Unless torch fishing is a handicap, the fact that residents of canoe-owning compounds torch fished is especially curious. These men achieved return rates more than four times higher when they trolled for yellowfin tuna than when they torch fished for dogtoothed tuna (Sosis, submitted b). Yet, the four men who fished 11 or more times were all residents of the canoe-owning compound on which they fished. If men are promoting the productivity of their matriline, these results are understandable. Men in the matriline who reside outside of the canoe-owning compound may have less motivation to torch fish than residents of the canoe-owning compound, since their offspring are not in the matriline. Men who reside in the canoe-owning compound are either unmarried or have unmarried children who also reside in the compound. Further work will be necessary to determine whether the gains that matriline members attain from torch fishing are achieved through increased mate quality and mating opportunities for younger members of the matriline.

If torch fishers are a bimodal population consisting of young men who are promoting their own work ethic and old men who are promoting the work ethic of the matriline, it may explain why there is no correlation between torch fishing frequency and palm sap production. If torch fishing is a costly signal advertising work ethic, torch fishing frequency should only predict palm sap production in young men. Unfortunately, by eliminating older married men from the sample, we are only left with palm sap production data for seven men. However, the percentage of risk days a man torch fishes is a significant predictor of the average amount of palm sap produced per event by these seven men ( $r = .75$ ;  $p = .05$ ). More data on palm sap production will be necessary to determine whether these results are evidence of a real effect. When older married men are eliminated from the sample of torch fishers, the percentage of risk days a man torch fishes is still not a significant predictor of mean per capita palm sap harvesting return rates or the number of palm trees a man cuts. An increase in palm sap collecting productivity during the summer could explain these results, although informants claimed that palm sap collection activities remained relatively constant throughout the year. It will be important to assess these claims empirically.

If torch fishers are a bimodal population, it also is important to demonstrate that torch fishing frequency is still a significant predictor of fishing effort and productivity if older men are eliminated from the analyses. Indeed, when the data are reanalyzed in a logistic regression model using only men 30 or younger, the percentage of risk events that a man torch fishes is a significant predictor of the percentage of risk days that a man morning trolls, rope, 9-mile reef, and solitary fishes, even controlling for age, clan affiliation, and educational status ( $n = 1029$ ,  $df = 4$ , partial  $p < .0001$ ). Multiple regression analyses show that the percentage of risk events a man torch fishes also remains a significant predictor of the average amount caught morning trolling, rope, 9-mile reef, and solitary fishing per day he was at risk controlling for age ( $n = 14$ ,  $r = .65$ ,  $df = 2$ ,  $p = .02$ ) and clan affiliation and educational sta-

tus ( $n = 11$ ,  $r = .72$ ,  $df = 3$ ,  $p = .04$ ). Marital status was not used as a control in these analyses because no fisher 30 or younger was married (Table 5).<sup>15</sup>

The suggestion that some men are torch fishing to promote the reputation of the matriline also may explain another feature of torch fishing. In addition to the torch fishers, the women of the canoe-owning matriline whose men are torch fishing also work extremely hard during torch fishing season. While the men are collecting fronds and making torches, the women of the matriline are producing and preparing food. They are not only preparing food for the men of their compound, which they would do normally, but they are preparing food for all of the torch fishers. In addition to the increase in the amount of food produced, these women also spend more time preparing each dish. Typically taro, breadfruit, and fish, the staples in the Ifaluk diet, are simply boiled in salt water and served. During torch fishing season, however, taro and breadfruit were mashed and cooked in coconut milk, a process that can take several hours.<sup>16</sup> Dogtoothed tuna were cooked in an underground oven, the only time during the field session in which fish were prepared in this manner. Indeed, everyone recognized that women often worked just as hard as men during the torch fishing season. It may be that women also are advertising their own work effort during the torch fishing season, as well as advertising the work effort of their matriline. Future research will need to focus on what benefits, if any, women are gaining by paying these substantial time and energy costs during the torch fishing season.<sup>17</sup>

### 5.2. *Could an Ifaluk fisher cheat on the torch fishing display?*

Is it possible for a man on Ifaluk to falsely advertise his work ethic? In other words, is it possible for a man to work hard for 1 to 2 months during the torch fishing season and then free-ride the rest of the year? This cannot be ruled out entirely, but it appears unlikely. Men who “cheat” on the torch fishing signal would be apparent in the lower right-hand corner of Fig. 1 (i.e., individuals who frequently torch fish but do not frequently fish otherwise). Notice that no one pursued a cheater strategy; all men who frequently torch fished also frequently fished throughout the trade wind season. It seems that the only way one could endure the torch fishing experience is to be in excellent physical condition, and the only way to accomplish that on Ifaluk is to regularly work. I cannot overstate the intensity of activity during a 13-day period in which 12 torch fishing events occurred. Some men averaged 2 to 3 hours of sleep per night, and on many nights men never bothered to sleep. After returning from torch fishing, these men would cook some of the catch and return to their canoe for the morning trolling.

If a man is able to falsely advertise his work ethic, it does not necessarily imply that the torch fishing display is an unstable signal. As long as a signal is honest “on average,” there is a possibility of occasional deceit of a signal (Johnstone, 1997). If such individuals are relatively rare in the population, the disadvantage that recipients suffer by occasionally believing a false signal will not destabilize the signal (Johnstone and Grafen, 1993).

<sup>15</sup> For complete analyses please contact the author.

<sup>16</sup> Taro and breadfruit were prepared in this manner for atoll-wide feasts.

<sup>17</sup> It also should be mentioned that historically a traditional dance (ur) was performed by unmarried women after the torch fishing season was completed (Bates and Abbott, 1958). There is still a yearly celebration and dance that occurs in early April, which does follow the torch fishing season, although its current relation with the torch fishing season is not clear.

### 5.3. *Is torch fishing a show-off strategy?*

The current data on torch fishing activities are unable to distinguish CST from the “show-off hypothesis,” formally developed by Hawkes (1991, 1993a). Hawkes has drawn attention to the fact that male foragers often pursue large game that, if subject to tolerated theft (Blurton Jones, 1987), are ultimately public goods (but see Hill and Kaplan, 1993; Hawkes, 1993b). Hawkes argues that hunters often pursue large game even when such prey choices lower their overall acquisition and/or consumption rate. She suggests that men might make these prey choices in order to achieve status benefits that accrue from providing these public goods. As Smith and Bird (2000) correctly note, CST and the show-off hypothesis are not mutually exclusive. Smith and Bird (2000) have argued that CST provides a more general framework for analyzing foraging decisions and is not limited to explaining why men hunt large game or provide public goods. Torch fishing on Ifaluk seems to be a case in point. Even though dogtoothed tuna may be the largest species of fish exploited on Ifaluk,<sup>18</sup> the returns from torch fishing are not a public good subject to tolerated theft. The catch is owned by the canoe-owning matriline that captured the fish and distributed by the elders of the matriline. Less than 14% by weight of the fish caught was left at the canoe house for only torch fishers to consume. The remaining 86% was distributed directly from the canoe-owning compound. On average, over 60% of this fish remained in the compound. Fish that were distributed typically were given to torch fishers in 1.2-kg packages, whereas on average the owners retained 14.3 kg (for further details on torch fishing sharing patterns, see Sosis, submitted b).

### 5.4. *Changes in the torch fishing ritual*

Torch fishing rituals have changed over the years, and fishers no longer adhere to many of the former restrictions (e.g., sexual abstinence, living at the canoe house; Burrows and Spiro, 1957). These changes are interesting because they suggest that torch fishing may not convey the same information that it once did, or the information that it transmits does not have the same value as it formerly had. Interesting differences between the populations on Ifaluk’s two inhabited atolls may provide an opportunity to study changes in the practice of torch fishing rituals. Falalop, the atoll where this study was conducted, is the more traditional of Ifaluk’s two inhabited atolls (this fact is recognized by everyone). With regard to torch fishing, the men of Falachig atoll did not adhere to all the restrictions that the men of Falalop claimed were necessary. Torch fishers on Falachig did not adhere to any dietary restrictions, nor did they refrain from using the flying fish they caught on the first 4 days as bait. They also did not consult the magician (who resides on Falalop) concerning when and where to fish. The men of Falalop often complained that Falachig torch fishers were breaking many rules; however, even on Falalop there were differences between the levels of adherence to tradition between the two matriline that torch fished. For example, the matriline that torch fished later in the season did not adhere to the 4-day waiting period on the pursuit of dogtoothed tuna.

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<sup>18</sup> The average size of a captured dogtoothed tuna (11.8 kg;  $n = 17$ ) was larger than the average size of a captured yellowfin tuna (9.6 kg;  $n = 289$ ), and this difference is nearly significant ( $p = .088$ ). However, only one (25.5 kg) of the five largest fish caught over the observation period were dogtoothed tuna. The remaining four, including the largest fish caught (27 kg), were all yellowfin tuna caught trolling in the morning.

Members of the other matriline protested, but felt somewhat redeemed when the offenders lost their hook and line on a rock during the first evening.

Why are there differences in the level of adherence to tradition between Ifaluk's atolls? The torch fishing signal may not have the same value for the populations of each atoll. There are 19 paid positions on Ifaluk.<sup>19</sup> All but two of these positions are held by men (and one woman) who reside on Falachig atoll. If torch fishing is a signal of fishing productivity, this signal may be less important on Falachig. Women on Falachig may be more interested in finding a husband who will be employed rather than a full-time fisherman. Further work will be necessary to evaluate the benefits, other than salary, that employees gain through employment, as well as the tradeoffs they face between salaried work and fishing productivity.

## 6. Conclusions

The results presented here suggest that CST may provide a powerful framework to understand certain foraging decisions among modern foragers. On Ifaluk, the sexual division of labor, which has been taken as a given here, limits the amount of information that men and women have about the work effort and productivity of prospective mates. Costly signaling and displays of quality may be more important in societies where ecological constraints limit the amount of information individuals possess about prospective mates, competitors, and allies. Future work should explore this possibility. Here I have provided some evidence that torch fishing is a handicap that advertises a man's productivity. More data on torch fishing activities will be necessary to assess what benefits torch fishers are achieving through this costly display, and whether variation in the frequency that men torch fish can explain variation in the benefits attained.

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<sup>19</sup> Employment on Ifaluk is limited to 10 elementary school teachers, 4 Head Start teachers, 2 Head Start cooks, 2 medical dispensators, 1 dentist, and 1 agriculturist. All jobs are held by men, with the exception of one of the Head Start cooking positions. Employees are paid roughly bimonthly when a Yap State government ship, the *Microspirit*, brings passengers and supplies to Ifaluk.

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