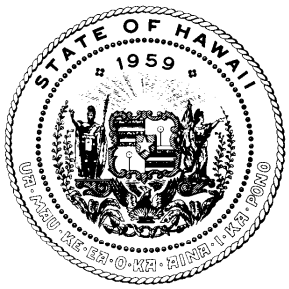
Department of Land and Natural Resources

Division of Aquatic Resources

Technical Report
06-01

Hawaii's Ulua and Papio Tagging Project 2000 to 2004

May 2006



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May 2006

Cover photos clockwise from left: Kyle Narimasu, John Kurahara and Scott Oshiro

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We would also like to thank the following people for lending their support and invaluable help to Hawaii's anglers and the Ulua Tagging Project. They include: William Devick (retired), Dan Polhemus, Francis Oishi, Walter Ikehara, Alton Miyasaka, Mike Yamamoto, Thomas Iwai Jr., M. Kimberly Lowe, Paul Murakawa, Rodney Young, Jason Leonard, Tracy Tanaka, Henry Okamoto (retired), Randy Honebrink and Reginald Kokubun of the Division of Aquatic Resources, Department of Land and Natural Resources (DLNR); Kitty Simonds and Mark Mitsuyasu of the Western Pacific Fishery Management Council (WESPAC); Kurt Kawamoto of the Pacific Islands Fisheries Science Center, NOAA Fisheries; Brooks Takenaka of the United Fishing Agency; Dr. John E. Randall and Arnold Suzumoto of the Bernice P. Bishop Museum, Dr. Richard E. Brock of the University of Hawaii Sea Grant College Program, Scott Furushima of the Kewalo Keiki Fishing Conservancy; Chuck Johnston and Brad Deffenbaugh of the Hawaii Fishing News, David and Leanne Hall of Hallprint Pty. Ltd.; Kay Davy of the The Billfish Foundation; John Gorman of the Maui Ocean Center; Michael Tokunaga of S. Tokunaga Fishing Supply; Brian Kimata of Brian's Fishing Supply; Jeffrey Rogers, Floyd Otani, Gary Dill, Bob Takeuchi, Edward Watanabe, Edwin Fukuchi, Robert Kikuta, Glenn Oyamot, Clay Ching, Kyle Narimasu, John Kurahara, Scott Oshiro, Leo Ohai, Kelvin Ching, Tony Costa, Ben Wong, Mike Sakamoto, and Marlene Tam.

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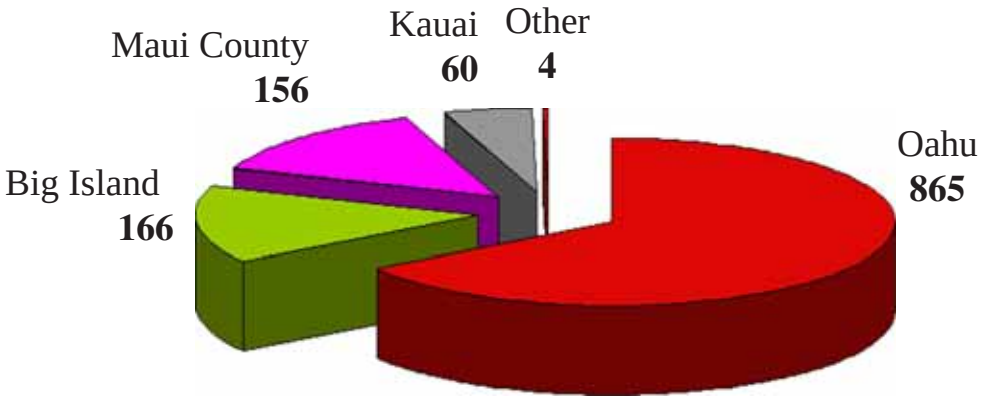
INTRODUCTION

The Department of Land and Natural Resources (DLNR), Division of Aquatic Resources (DAR) administers a statewide volunteer angler-based fish tagging program (DAR's Ulua Tagging Project). Volunteer anglers are asked to capture, tag and release all marine fish species known as ulua and papio, also known as jacks, which are classified under the Family Carangidae. Locally, the term "ulua" refers to jacks that are 10 lbs. or more in weight while those that are under 10 lbs. are referred to as "papio". These species contribute to and account for the most popular recreational fishery in the entire state. Yet there is little information available regarding the status of these species in Hawaii. Utilizing local fishermen as volunteer taggers has proven to be the most effective arrangement to gather this much needed information. The combined tagging efforts of volunteer anglers produce a large volume of tagged fish information, which provides the critical data that is needed to assess the ulua and papio resources at minimal cost. As island populations continue to grow, the increased demand on these resources may jeopardize the supply of these fishery stocks. More information on these species is needed to promote better management strategies to keep up with current and future demands by the islands' fishing communities.

HISTORICAL INFORMATION

Initial efforts for this tagging program were developed by DAR's Hilo branch office with the help of a few members of the Hilo Casting Club. Fishermen have expressed strong concern on the overall condition of the ulua and papio resources in Hawaii. Historically, there has always been fishing pressure for ulua and papio in Hawaii. Due to their initiative, members of the Hilo Casting Club and Big Island Casting Club began tagging ulua and papio on the Big Island in 1997. In July 2000, the Division had the opportunity to expand the project to include volunteer fishermen statewide. As of December 2004 the project has acquired a total of 1,251 volunteer anglers (See Figure 1.) with the majority of anglers being located on the island of Oahu.

Figure 1. Total Number of Volunteer Anglers By County as of 12/31/04



Total = **1251** Volunteer Anglers

Fig. 2. Ulua Tagging Project brohure

Logistics play a key role in the distribution of volunteer anglers statewide. Since the project is headquartered on Oahu, it is easier for DAR project staff to work with these anglers directly. With limited neighbor island staff available, recruitment of volunteer anglers from the neighbor islands is highly dependent upon sharing information on tagged and recaptured fish, word of mouth, brochures, news articles, local television fishing programs and telephone.

The popularity of the Ulua Tagging Project is evident from Figure 3a, which shows the number of new volunteer anglers that have joined the project each year since the project was expanded statewide. As of December 2004, 33,300 tags were distributed among the project's volunteer anglers that have been used to tag 17,980 fish statewide (Figure 3b) from the Island of Hawaii to Midway Atoll.

Volunteer Angler Participation

Tagging kits are provided free of charge to all anglers interested in volunteering their services to assist DAR with the capture, tag, and release of the targeted jack species. Each tagging kit includes 2 to 3 Hallprint brand dart tags, a tag applicator, instruction manual, Tagging Tips manual, tape measure, postage paid data return card, species identification sheet, the current Hawaii Fishing Rules and Regulations pamphlet, and various other related material.

Figure 3a. New Anglers Volunteering By Calendar Year

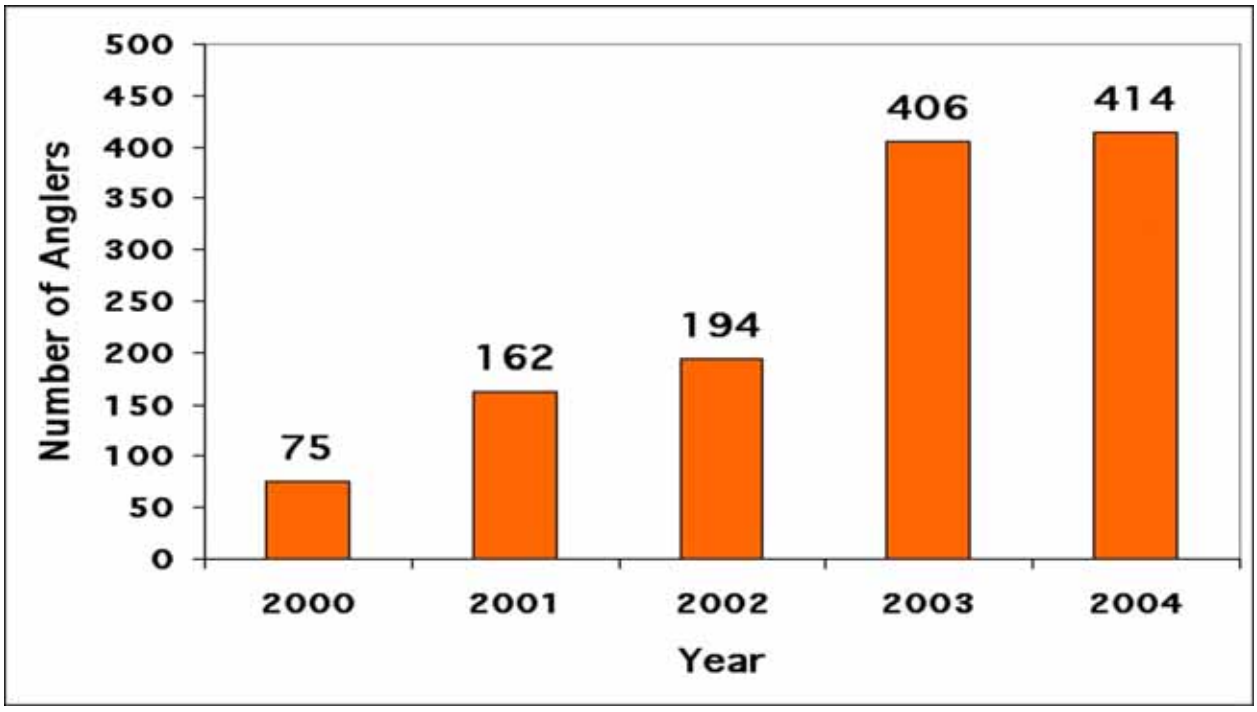


Figure 3b. Comparison of Tags Distributed and Fish Tagged by Calendar Year

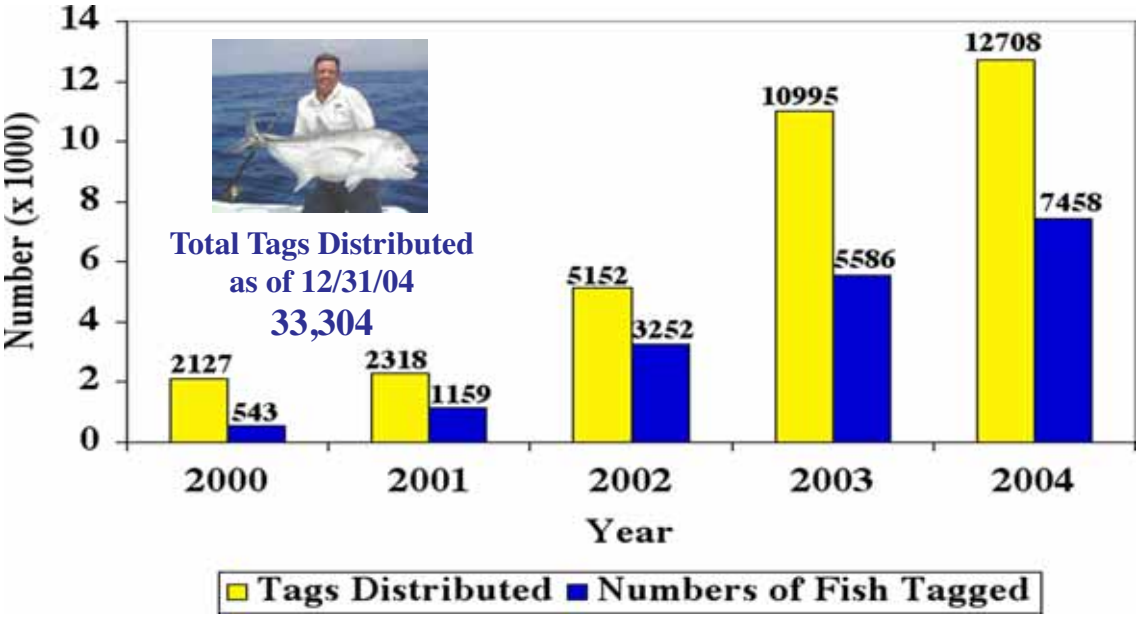


Table 1. Total Number of Fish Tagged By Species as of 12/31/04

Species Common Name	Species	Number Tagged	Size Ranges (inches Fork Length)	Number Recaptured
Kahala, Amberjack	Seriola spp.	1681	6 to 65	157
White ulua/papio, Giant trevally	Caranx ignobilis	4661	4.5 to 58.5	616
Omilu, Blue trevally	Caranx melampygus	10571	4 to 40	1749
Butaguchi, Buta Ulua, Thicklipped jack	Pseudocaranx dentex	100	20 to 36.5	0
Papa, Yellow-spotted trevally, Island jack	Carangoides orthogrammus	332	6 to 26.5	16
Black ulua, Gunkan, Black trevally	Caranx lugubris	4	28 to 34.5	0
Kagami, Mirror trevally, Threadfin jack	Alectis indicus	28	3.5 to 38	2
Menpachi ulua, Sasa, Bigeye trevally	Caranx sexfasciatus	348	4 to 17	21
Barred jack	Carangoides ferdau	95	5 to 21	25
Pao'pao, Yellow ulua, Golden trevally	Gnathanodon speciosus	55	5 to 31	15
Dobe papio, Whitemouth jack	Uraspis helvolus	18	7.5 to 14	0
Ulua, Papio	Misc. Jacks	87	5 to 28	0
	TOTAL FISH TAGGED	17980	TOTAL FISH RECOVERED AS OF 12/31/04	2601 (=14.5% Recapture Rate)

Each dart tag has a specific alpha numeric code that is registered to the individual angler who was given the tag. This information is housed in a database for identification and data tracking purposes. Each angler is responsible for their own set of tags and for recording specific information for each fish tagged and released. Specific information includes 1) Tag Number, 2) Date Tagged, 3) Species, 4) Fork Length, 5) Time Caught and 6) Location Caught. Volunteer anglers are asked to record this information on the postage paid data return card (Appendix A) and mail the card to DAR. Anglers may have the option of emailing or calling in their data to the DAR office. They are also encouraged to keep a copy of their own personal data as a back up in case the original copy becomes misplaced or lost in the mail.

Recovery process

The success of the program is highly dependent upon fishermen participation to recover tagged individuals and provide DAR with information on 1) Who caught the fish, 2) Tag number, 3) Date of Capture, 4) Time of Recapture, 5) Location of capture, 6) Species and 7) Fork Length measurement. This information is processed and DAR awards the angler for each tag reported and/or returned along with a letter regarding the history of the fish that was caught (Appendix B). Volunteer taggers are also notified with a letter if one of their fish has been caught regarding the history of that fish (Appendix C). Once an angler becomes aware of the project, they are anxious to learn more about the fishery. As anglers become more involved in the project, they are more apt to re-release tagged fish once the recapture information is recorded.

RESULTS

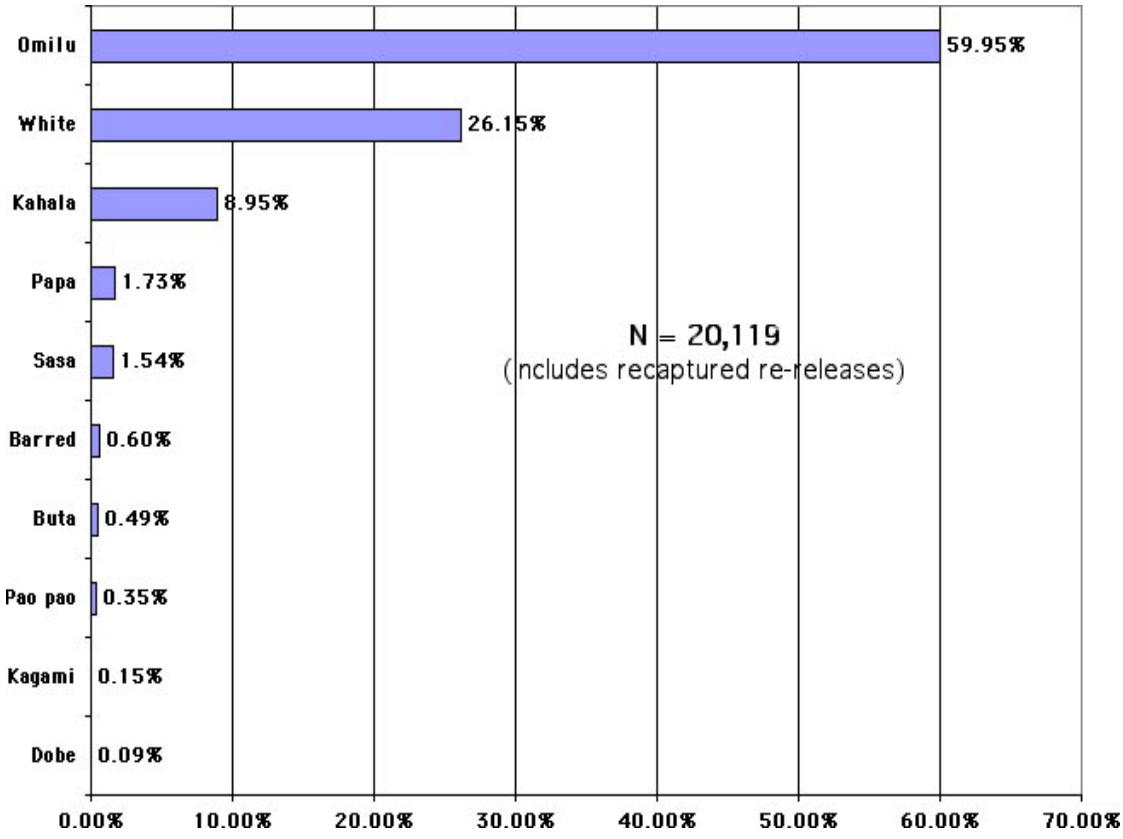
Tag, release and recovery efforts have given us good information on the papio fishery in terms of seasonal recruitment, growth, and movement patterns on fish up to 13 inches in fork length. However, there are still questions regarding the larger ones (over 13" FL) and where they are found, their changes in growth rates and behavior patterns. As these larger fish reach sexual maturity, recoveries in this size range and larger will provide additional information on the movement and behavior of spawning stocks. DAR anticipates recovering more information on papio species in this size range over time as these fish mature. Fish in this size range are in great demand by many sectors of Hawaii's diverse fishing communities.

A good rapport among shoreline anglers and project staff has been developed through the project. As a result, this has established a direct line of communication between the anglers and project staff where additional information outside of the tagging data can be collected and used to complement and support tag and recovery data. For example, anglers will call to inform and report to project staff that there is an abundance of a certain species of bait fish along the shoreline indicating that food sources will be available to support the year's incoming recruitment of papio.

Species composition of the ulua and papio fishery is based on the assumption that tagging efforts reflect a representative cross section of this fishery as illustrated in Figure 4. The majority of the ulua and papio fishery, 86.1%, is composed of the omilu and white ulua and papio species. The next abundant groups would be the papa, sasa, and barred jack species comprising 3.87%, and the remaining 0.59% consists of the pa'opa'o, kagami, and dobe species. The remaining species, kahala

and butaguchi, are deeper bottomfish species and not as accessible to shoreline anglers, but comprise 9.44% of the fish being tagged in the program. This report will attempt to review the tag and recovery information on each species with available data up to 12/31/04.

Figure 4. Species Composition of Tagged Carangid species



Omilu, Bluefin Trevally

Caranx melampygus

Out of 10,571 omilu that have been tagged as of December 2004, 1,749 individual fish were recaptured (16.5% recovery rate) providing valuable information on growth and movement. Out of these 1,749 individual fish, 1,481 were recaptured at least 1x, 225 were recaptured 2x, 34 were recaptured 3x, 8 were recaptured 4x and 1 individual was recaptured 5x. As anglers become more aware and involved with the project, they are more apt to re-release a tagged fish because of their interest in obtaining more information on that particular fish. This has worked really well for the project because we are able to track how long each individual fish may remain in an area over a given time period and approximate when it begins to migrate.

OMILU RECRUITMENT

The earliest indication of the first recruitment of the smallest size class of juvenile omilu recruiting inshore for the year are taken from reports by volunteer anglers of 2 to 3-inch juvenile omilu recruiting inshore beginning in May. In June, more volunteers report observing a few 3" papio

Figure 5a. 2003 Omilu Recruits (4 to 6 inches fork length)

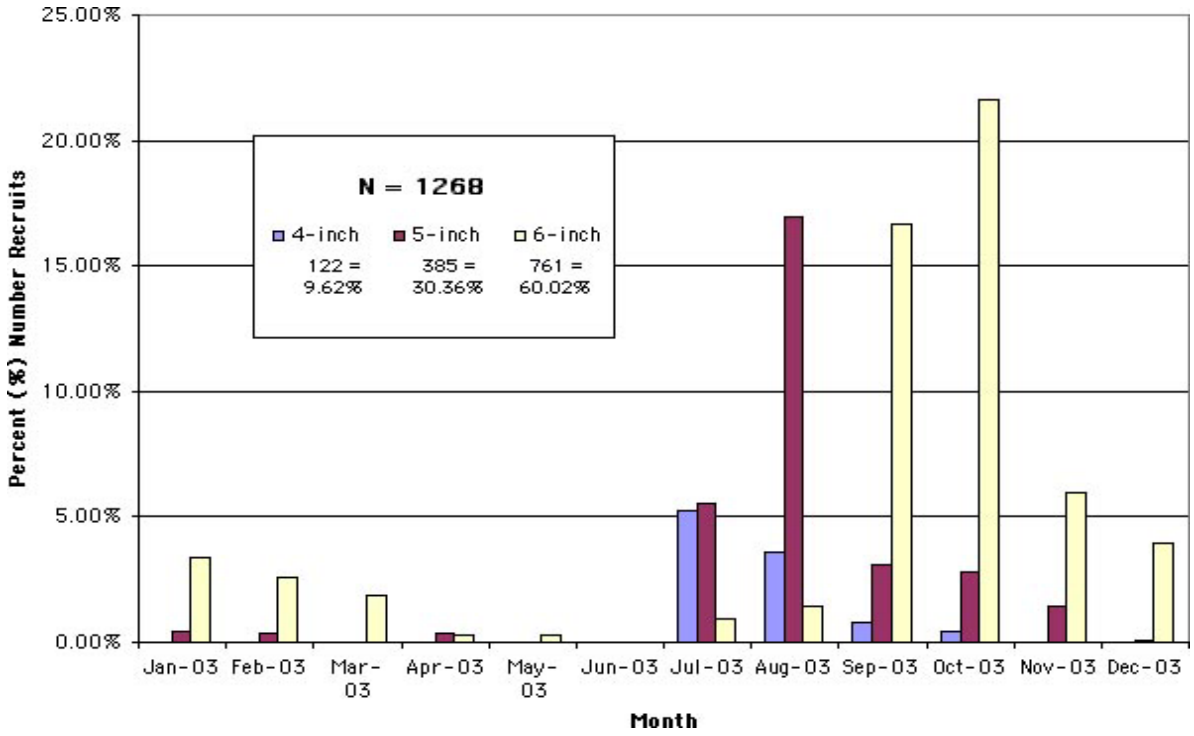
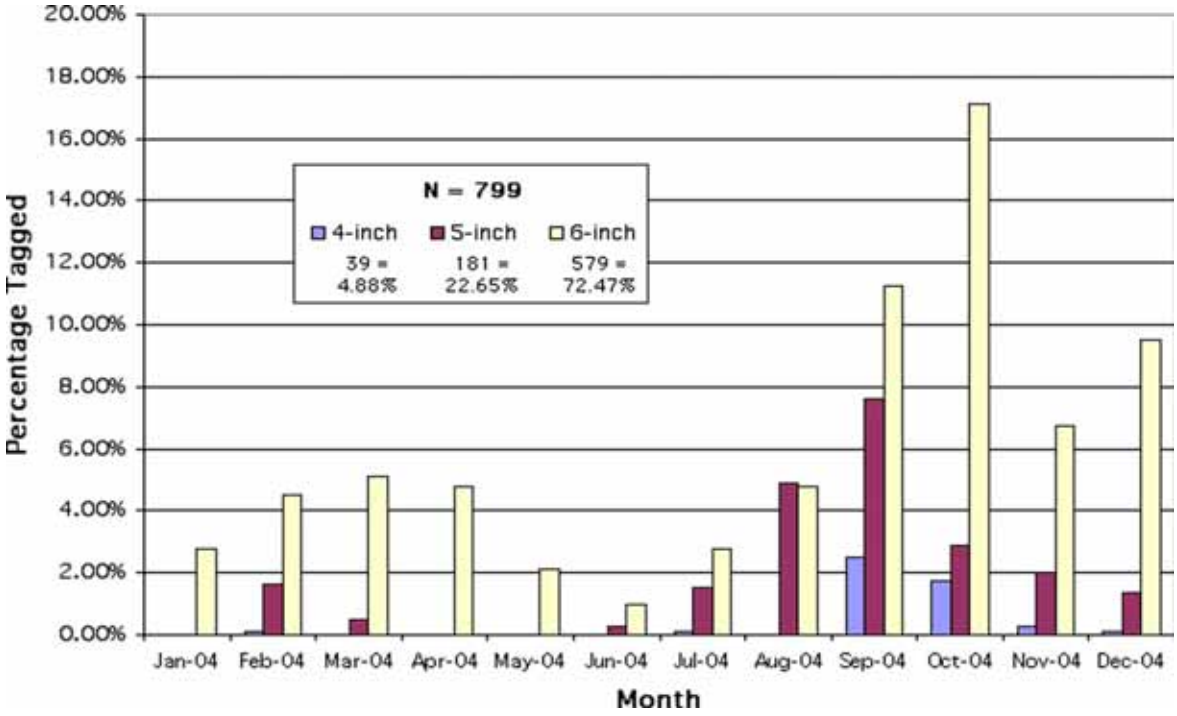


Figure 5b. 2004 Omilu Recruits (4 to 6 inches fork length)



along the shoreline. This indicates that anglers will begin seeing some numbers of 4" individuals by the following month in July. This pattern has been consistent for 2002 and 2003 and recruitment happens simultaneously throughout the state. It is assumed that the 3 to 4-inch individuals are the results of the previous year's first spawn. Spawning for this species is said to occur between the months of April to November with peaks in May through August (Sudekum et al.,1991).

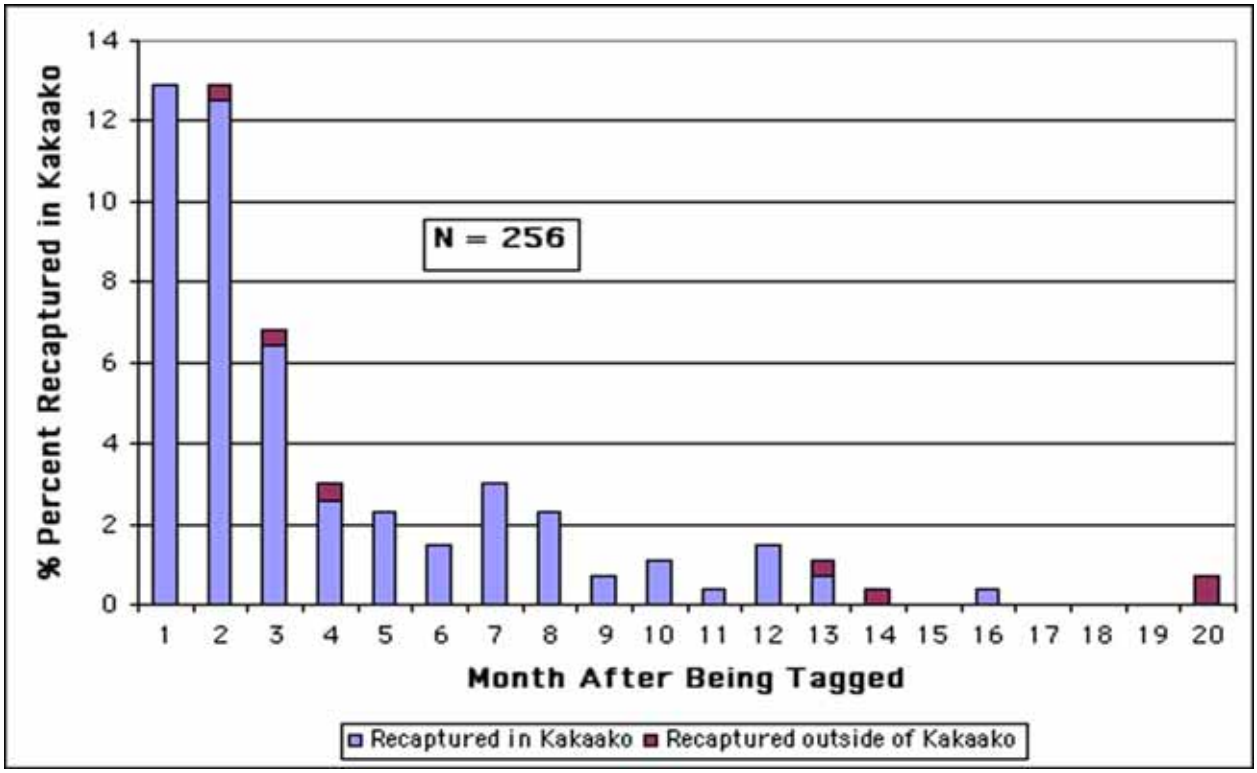
By the time these fish reach 5 to 6-inches FL it appears that the majority of the papio have entered the fishery as is indicated by the large percentage of fish being tagged at this size during the recruitment period. Juvenile omilu at 4 to 6-inches fork length typically appear along the shoreline between July to September with peak recruitments occurring in August (Figure 5a).

Tag and release data indicates that the 2004 recruit class of juvenile omilu in the 4 to 6-inch size class range appears to be half of what it was in the previous two years (Figure 5b). Normally, what coincides with the recruitment of juvenile omilu is the recruitment of juvenile goatfish (oama), *Mulloides flavolineatus*, which is a favored food of the larger omilu (see GROWTH section, Omilu). At times the annual runs of these juvenile goatfish will be very lean or nonexistent and 2004 happened to be one of those years. Movement data from recaptures of omilu and white papio indicate that ocean current patterns were different from previous years and this may have contributed to the lack of juvenile goatfish in 2004 (see Appendix D and DAR 2005). This lack of oama may also indicate a lack of suitable prey items available for the omilu recruits resulting with a drop in the numbers of 4 to 6-inch individuals being caught in 2004. The lack of food for the larger adult omilu may affect their spawning rates for 2004 and in turn affect the recruitment of juveniles in 2005. Continued monitoring of tag and release efforts for this species may be able to provide some indication of recruitment for 2005.

Generally tag and recovery data indicate juvenile omilu will remain within an area till they reach about 9.5" fork length. At this size, recapture data indicate that they will begin to migrate outside of this area. There is speculation that the dietary habits of the omilu at 9.5" FL are perhaps changing and/or expanding to include other larger prey items that may not be abundant in that area. The oama are known to recruit annually inshore in large schools during the months of June through September and in some years recruitment will extend into November. The oama is considered a favored food of the larger omilu and is popularly used for bait in catching this species. Larger omilu include those that measure 9.5" FL and over. At these sizes, the omilu are large enough to consume the oama which range in size from 3" to 4" in length during the period they are inshore. When the oama recruitment subsides and slowly disappears from the shoreline, the high majority of omilu that are 9.5" FL or larger are not seen again or they are recaptured outside of the area that they were last reportedly seen (tagged and/or recaptured).

Based on tag and recovery data from the Kakaako area on Oahu, there appears to be a yearly turnover in recruitment of juvenile omilu within a given area. The vast majority of recruits are not seen in the same area outside of 1 year's time from the day of recruitment, as it is depicted for 2001 in Figure 6 below. As the years pass, we see less and less of the original recruits within the same area. As they get older and larger, they tend to be found outside of the area. Recovery data shows that pending food availability, the majority of the year's recruits will double in length from 6" to 7" FL reaching 12" to 14" FL by the following year. At 12" to 14" FL, the omilu are at or near sexual maturity (Sudekum et al.,1991). At this size range, these fish would have likely left the area allowing the new year's recruits to settle in its place.

Figure 6. Recapture Rate of Kakaako Omilu Tagged in 2001



Concentrations of juvenile omilu have been tagged and released in areas such as Kakaako, Bishop Pt. at Hickam AFB on Oahu; Paia, Maalaea Harbor and Kihei on Maui; Hilo/Keaukaha on the Big Island; Anini Beach on Kauai; and various other areas throughout the state on each island. These areas are generally within the vicinity of some freshwater influx either due to freshwater streams or some other freshwater sources. It appears that these juvenile omilu prefer to inhabit the outer edges of an estuarine environment such as the areas previously mentioned. These areas may serve as nursery grounds for this species as is evidenced by large annual recruitments of omilu ranging from 4" to 6" inches FL.

Occasionally the larger adult omilu may be found in these areas. These larger adult omilu have been tagged and/or recaptured mostly during the time the prey items or bait are present inshore. Otherwise, recovery data indicates they are generally found further offshore.

GROWTH

Growth rates are based on fish that were at liberty between 14 to 45 days (averaging 30 days of freedom) to reflect monthly growth rates. In general, fish within the same size classes that were tagged and recovered within the same area had higher growth rates than those fish that were recovered 1 or more miles outside of the original area that they were tagged and released (See Figure 7). It appears that traveling has an impact on the growth rate of this species. Other factors that may affect growth rates are food availability, genetics, etc.

Figure 7. Average Monthly Growth of Stationary Omilu vs. Omilu Traveling 1+ miles

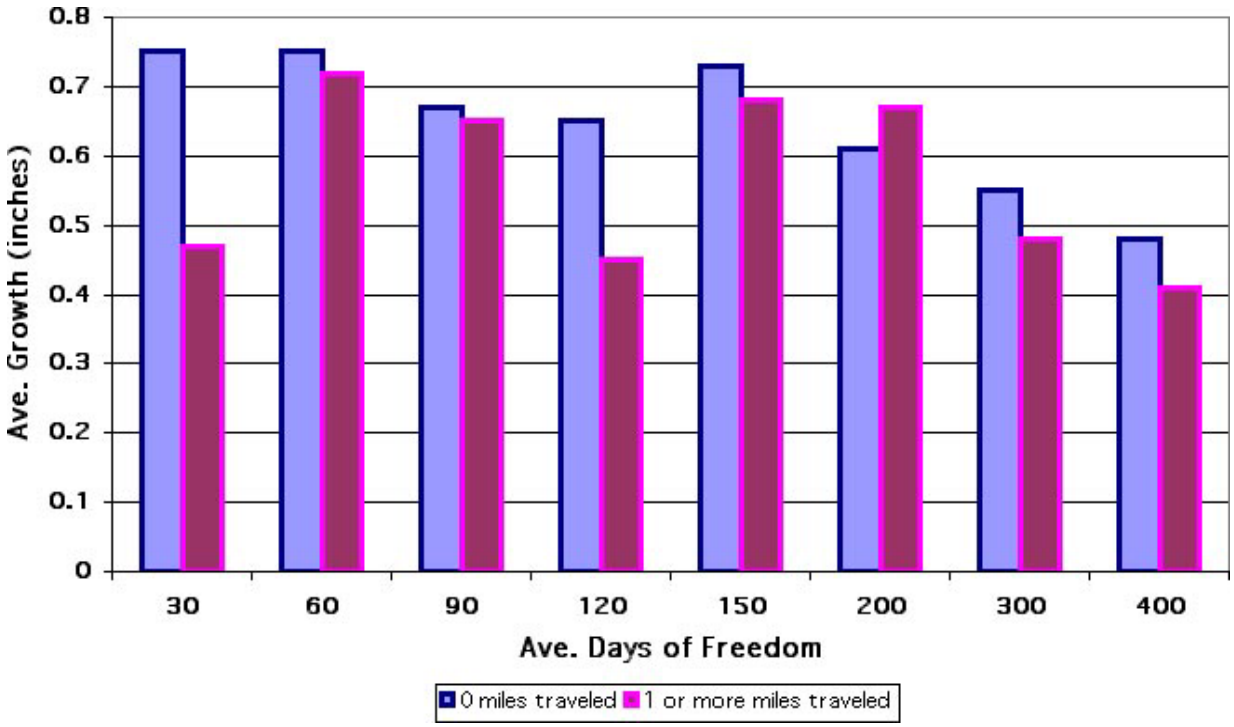
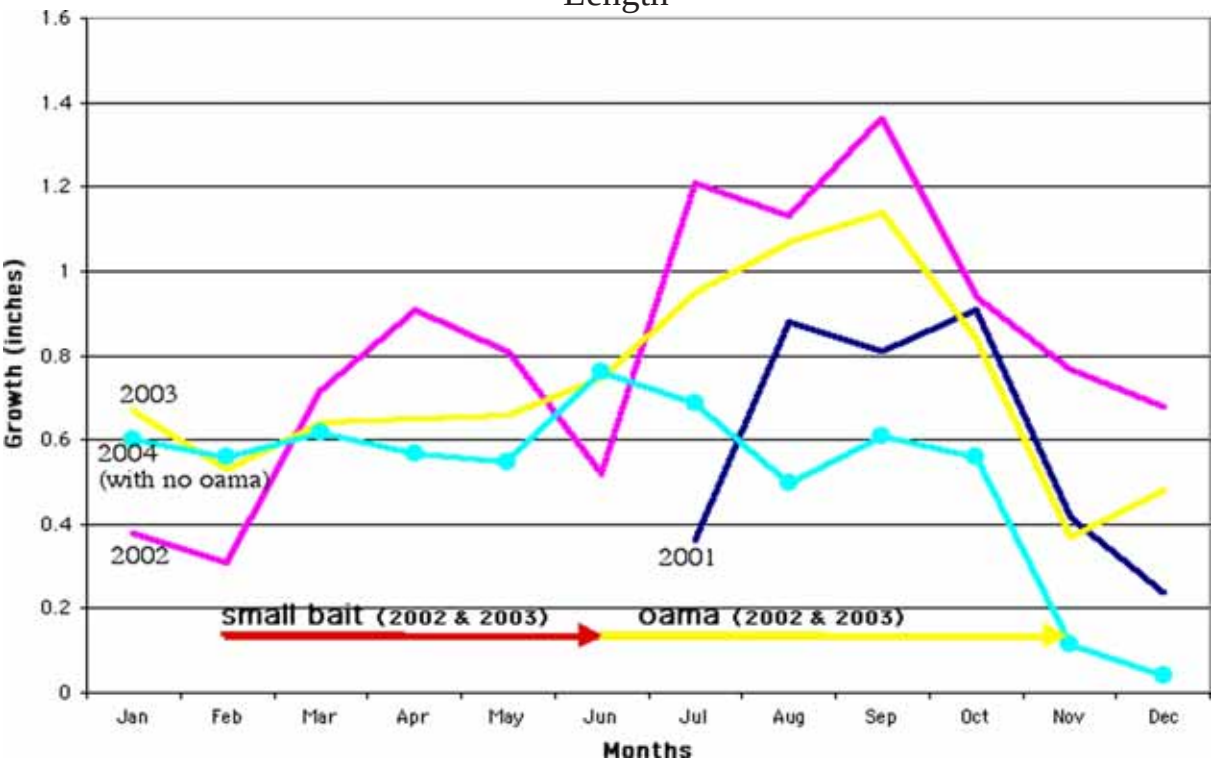


Figure 8. Average Monthly Growth Rates of Omilu at 4.5 to 13 inches Fork Length



Juvenile growth

Omilu at fork lengths of 4 to 5-inches exhibit tremendous growth spurts probably due to the fact that a large number of small prey items have also recruited nearshore (See Fig. 8). Since juvenile oama recruit inshore during the same time as the juvenile omilu, the occurrences of oama are used as indicators of various other small/juvenile prey items that may have also recruited inshore at the same time. The oama are a favored food of the omilu, but they are too large for the smaller newly recruited omilu to eat. However, tag and recapture data indicate that newly recruited omilu are growing indicating that food sources are available for these smaller fish.

The graph in Figure 8 illustrates the average growth rate per month of juvenile omilu ranging from 4.5" to 13" FL. during 2001 to 2004. As Fig. 8 indicates, the growth rate per month is related to the recruitment of prey items (food) for the juvenile omilu. Using oama as an indicator species, oama season (when the oama recruit inshore), as previously stated, usually occurs each year from June through September and in some years through to November. During this time period, juvenile omilu exhibit average growth rates of approximately 1 inch per month. From November to February growth rates are generally at their lowest compared to the rest of the year. From March to May there seems to be a small growth spurt (between 0.75 to <1 inch per month) occurring probably as a result of the recruitment of some other small prey items inshore such as juvenile squid, crab megalops larvae, etc. The recruitment of these small prey items as they occur are reported to DAR by volunteer anglers. From June to July, the growth rate immediately rises up again to an average 1+ inch per month as the new oama season begins. For species with seasonally oscillating growth rates, normally growth is faster during the summer months and slower during the winter when some species may even stop growing entirely (Longhurst and Pauly 1987).

However, in 2004, the annual summer recruitment of oama was very sparse and/or nonexistent. The growth rates of omilu recaptured between July 2004 and December 2004 were half or less than what they were in previous years. This indicates a relationship between the growth rates of omilu and the annual recruitment of oama. In 2004, fish recaptured between the months of July and December exhibited erratic patterns of movement around the island of Oahu indicating that ocean current patterns may have been switching back and forth (see Omilu MOVEMENT/MIGRATION Section). This pattern of currents switching back and forth as indicated by fish movement has not been seen in previous years. Also, this switching back and forth of the current occurred during the time the juvenile oama were expected to recruit inshore, which may have been a contributing factor to the oama not recruiting nearshore for 2004 (see Appendix D and DAR 2005).

Adult growth

As of December 2004, there have been 101 recoveries of omilu that were originally tagged at 13" FL and over. At 13" FL, the omilu is considered sexually mature and an adult (Sudekum et al.,1991). Generally, the growth rate from 13-inches and over appears to slow down quite a bit. The size ranges of these fish when they were recaptured range from 13" FL to 23.62" FL with an average growth rate of approximately 3.5 inches per year (0 to 5.5 inches in range) and average days of freedom set at 83 days (2 to 644 range). There is some preliminary evidence suggesting that growth for fish 13" FL and over may be directed at weight gain rather than growth in length as there is some tag and recapture data indicating that some individual fish had doubled in weight within a year's time. Further investigation is needed to confirm this.

MOVEMENT/MIGRATION

There seems to be a general clockwise and/or counterclockwise movement pattern around each island for all species observed. Movement appears to be highly dependent upon several factors such as size/age of maturity, food availability, ocean current patterns, climatic conditions, etc. However, we think that the primary motivation for movement is the search for food. Fishermen think that fish will orient themselves against the current flow to maximize their chances of finding food since the food will travel towards the them. As such, the fish tend to move in the opposite direction of the current at the time. The majority of these movement patterns have been revealed through the tag and recovery data of the omilu and white papio. Since their movement patterns are very similar, they will be summarized together and considered the same for both species.

As previously mentioned, recapture data has indicated that these species will begin to travel distances of 2 or more miles when they reach a fork length of 9.5" or more. This has been documented through recovery data particularly in areas where the same fish has been recaptured and released several times. Prime examples of such areas on Oahu include Kakaako where over 2000 omilu have been tagged, Pearl Harbor where over 1400 omilu have been tagged, and the Ala Wai Canal where close to 1500 white papio have been tagged. The high majority of the fish that have been recaptured 2 miles or further from the original area they were tagged measured 9.5" in fork length or larger upon recapture (Tables 2a and 2b and Figures 9a,b & c).

Out of the 275 combined total of omilu and white papio that had traveled 2 or more miles in

Table 2a. Average Fork Length and Average Days of Freedom for Omilu traveling 2 or more miles in distance

Distance Traveled (miles)	Number Recaptured	Ave. Fork Length at Recapture	Ave. Days of Freedom
2	25	11.1	134 (3 to 470 range)
3	8	11.2	109 (11 to 276 range)
4	3	13.5	130 (23 to 299 range)
5	6	12.6	93 (26 to 202 range)
6	10	11.3	139 (45 to 416 range)
7	4	11.1	124 (31 to 313 range)
8	4	11.0	130 (64 to 278 range)
9	3	13.3	108 (94 to 132 range)
10	1	11	141 (no range)
11 to 14.9	2	12.5	209 (21 to 397 range)
15 to 19.9	2	10.3	106 (58 to 154 range)
20 to 29.9	9	12.2	148 (17 to 516 range)
30 to 39.9	11	10.4	104 (2 to 306 range)
40 to 62.2	5	13	164 (64 to 319 range)

Table 2b. Average Fork Length and Average Days of Freedom for White Papio traveling 2 or more miles in distance

Distance Traveled (miles)	Number Recaptured	Ave. Fork Length at Recapture	Ave. Days of Freedom
2	35	12.5	158 (2 to 834 range)
3	8	11.9	153 (14 to 338 range)
4	13	11.3	149 (18 to 390 range)
5	11	15.0	106 (11 to 356 range)
6	10	17.1	266 (15 to 765 range)
7	10	11.5	175 (25 t0 306 range)
8	4	12.8	126 (51 to 207 range)
9	5	10.6	103 (55 to 165 range)
10	3	11.5	191 (108 to 340 range)
11 to 14.9	12	16.0	224 (35 to 631 range)
15 to 19.9	7	15.3	249 (104 to 374 range)
20 to 29.9	12	14.3	329 (86 to 620 range)
30 to 39.9	5	21.0	424 (176 to 1083 range)
40 to 62.2	9	19.0	372 (149 to 746 range)

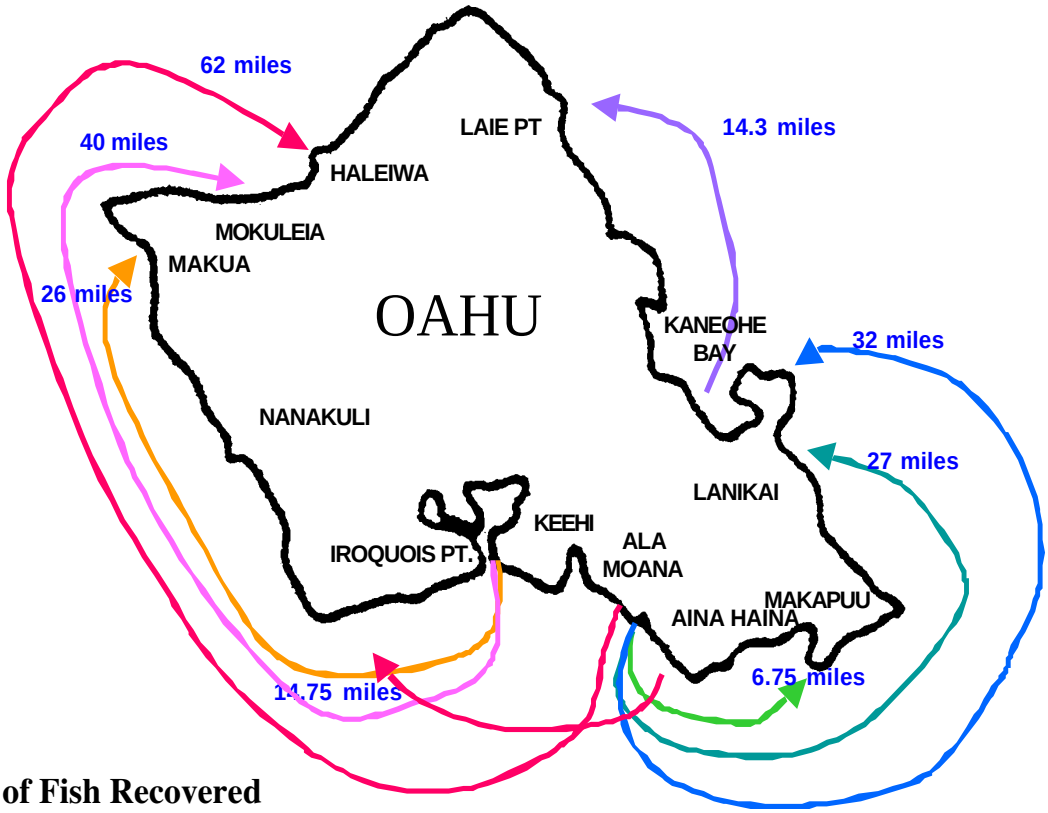
distance, 15 out of 188 omilu and 15 out of 157 white papio were recaptured measuring below 9.5" FL. Movement of these smaller fish (6" to 9.25" FL) seems to occur either before the summer months prior to the recruitment of various prey items or during the late summer to early fall months when the recruitment of prey items begins to slow down. The exception to this would be for the smaller omilu in 2004 when the recruitment of the oama was sparse. During June and July 2004, 3 recaptured omilu measuring 8" to 9.25" FL had traveled between 4 to 37 miles in distance from the original area tagged. Based on the above information, movement of these smaller fish may be related to their search for additional food sources. More information and research is needed to confirm this.

In addition, a pair of omilu tagged at 5" FL in the same month and location on Oahu were recaptured a month later at 7" FL, both in the same location 3 miles away. On the island of Maui, a pair of white papio tagged at 7.5" FL in the same month and location were recaptured a month later at 7.5" FL, also both in the same location over 4 miles away. This may be indicative that some of

these smaller fish are perhaps traveling these longer distances together or in schools. Fish at these sizes are highly vulnerable to predators and a possible reason for traveling in numbers may be for protection. More information is needed to confirm this.

However, most of the time, the areas that these smaller fish inhabit appears to have enough food to sustain them till they reach 9.5" FL. The majorities of the fish that have reached 9.5" FL and over begin to show movement out of the area. The few remaining fish that are 9.5" FL and over may be relying on a limited amount of food sources and will likely remain in the area until the food sources

Figure 9a. Movement Patterns of Omilu and White Papio on the Island of Oahu

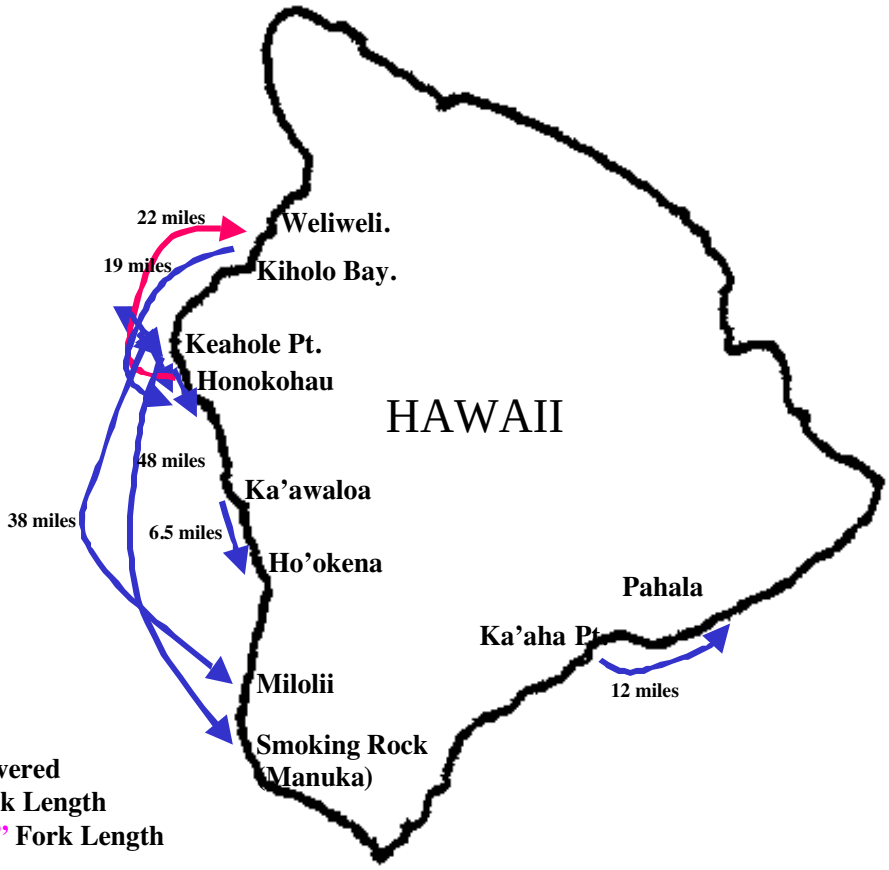


Size Range of Fish Recovered
Omilu - 10.5" to 14" Fork Length
White Papio - 9.5" to 18" Fork Length

are depleted. At that time, if they are 9.5" FL or larger, they will probably begin moving out of the area. It is at this size that the omilu will begin to feed on the oama and the white papio will begin to feed on the introduced gold spot herring, *Herklotsichthys quadrimaculatus*. It is suspected that at 9.5" FL, the diet for both these species may begin to change and in response, they move out of the area in search of more appropriate food items. Data shows that the white papio is farther ranging than the omilu indicating that there may be some differences in their diets at this size.

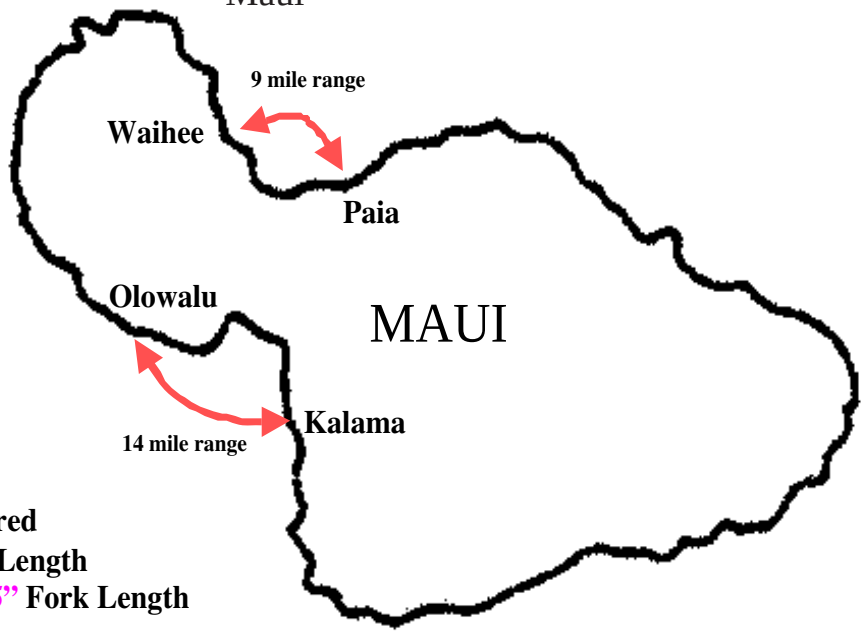
As mentioned previously, the data thus far indicates that these fish swim in a general clockwise and/or counterclockwise direction around each Island. Directional movement is based on the majority of fish that were recaptured during the month indicating travel in a particular direction. If a

Figure 9b. Movement Patterns of Omilu and White Papio on the Island of Hawaii



Size Range of Fish Recovered
Omilu - 13" to 23.6" Fork Length
White Papio - 9.5" to 40" Fork Length

Figure 9c. Movement Pattern ranges of Omilu and White Papio on the Island of Maui



Size Range of Fish Recovered
Omilu - 8.75" to 12" Fork Length
White Papio - 7.5" to 13.25" Fork Length

majority of 66.7% or more of the fish recaptured in one month moved in any one direction, this determines the general movement pattern of these fish during that particular month. Based on the assumption that fish will orient themselves against the current flow, the opposite direction of the fish movement would indicate the directional movement of ocean current patterns for that month. If there were no majority percentage of fish traveling during the month of 66.7% or more, this would indicate no general direction in movement perhaps indicating a switch in the directional movement of ocean current patterns. Available data on directional movement of ocean current patterns occurring during the same time period as fish movement is needed to confirm that the directional movement of the omilu and white papio correlate with the direction of prevailing ocean currents. Recovery data from 2001 to 2002 gave preliminary indications that the majority of omilu and white papio were moving counterclockwise around the island of Oahu roughly between March to September and would switch to a clockwise direction from September till March of the following year. As tag and recovery efforts increased in 2003, there was more recovery data that supported this same movement pattern up until July 2003. At this point, the papio began swimming in both directions around the island with no general pattern. This may have indicated that the current patterns were switching directions during this time. During August 2003, 91% of the fish recaptured exhibited a definite clockwise movement pattern around the island of Oahu. In September and October 2003, the papio again began exhibiting movement patterns in both directions around the island. From November 2003 and on into 2004, the directional movement of recaptured fish were switching from one direction to another from month to month indicating that the current patterns were not normal. Seasonal fishermen have also noticed this change in current patterns and confirmed this with experiences of shorter than normal time periods taken to return home from a trip up to the Northwestern Hawaiian Islands (NWHI) with their fishing vessels. During the month of June when fishermen are returning home from a trip up to the NWHI, they would normally be traveling home in an easterly direction going against a westerly direction current. In June 2003 when they were coming home from an NWHI trip, they noticed that the currents were running in an easterly direction. As a result, their boats were traveling at double the speed of 7 knots instead of the normal 3 knots, speeding up their travel time home (personal comm., Gary Dill 2003).

In addition to the unusual bloom of juvenile *Priacanthus meeki*, there were other reports by volunteer anglers in 2003 of higher than normal recruits of juvenile reef fishes. These anomalies regarding other fishery resources that have occurred during these unusual current patterns can be used, along with fish movement patterns, to monitor what may be happening with our nearshore fisheries (Appendix D). The combination of movement patterns along with anecdotal information from volunteer anglers can prove a valuable tool for monitoring our nearshore resources.

SIZE CLASS DISTRIBUTION

Fishermen observations along with tag and recovery data indicate a distribution pattern of younger and smaller omilu occurring along the shoreline and successively larger ones occurring further offshore. Tagging data shows that a portion of the tagged 9-inch omilus are being caught a few yards offshore from boats indicating that these fish were starting to move offshore at this size.

Figures 10a,b&c illustrate the percentages of the different size classes of omilu as they are sampled along the shoreline with tagging efforts from 2002 to 2004. High numbers of 4 to 8 inch omilu

were observed along the shoreline during the summer to fall months appearing to correspond with the time that the oama, *Mulloides flavolineatus*, are also inshore. The numbers of 9-inch and larger omilu caught nearshore also peaked slightly during the same time that the oama were in. It is during this time period when the oama are in that some larger individuals measuring over 9" FL will come inshore to feed on the oama, but overall the larger omilu were not found in large numbers inshore.

There was a decrease in the percentage of new omilu recruits (4" to 6" FL size class) for 2004 (Figure 10c). This is most likely related to a lack of the normally expected recruitments of oama across the state during the year. Without the small prey items that recruit inshore along with the oama, it is suspected that there may not have been enough food to support the new omilu recruits resulting in smaller numbers of omilu. It is expected that when the large oama recruitments return in following years, the numbers of omilu in the 4" to 6" FL size class range will also increase.

In 2003, there appeared to be an increase along the shoreline in the percentages of omilu in the larger size classes of 9" to 10" FL and over during the months that prey items (food) have recruited inshore (see Figure 10b). This trend appeared to continue in 2004 (Figure 10c). This increase may be attributed to a number of factors including an increase in the regulation on minimum size for take or consumption (from 7" total length (TL) to 10" FL as of 12/19/02), a previously successful recruitment year, successful recruitment of prey/bait items, or even an increase in the overall effort of anglers practicing catch and release. Monitoring tag and recovery data will provide information on whether this trend will continue over time.

Figure 10a. Percentages of Omilu by Size Class per Month During 2002

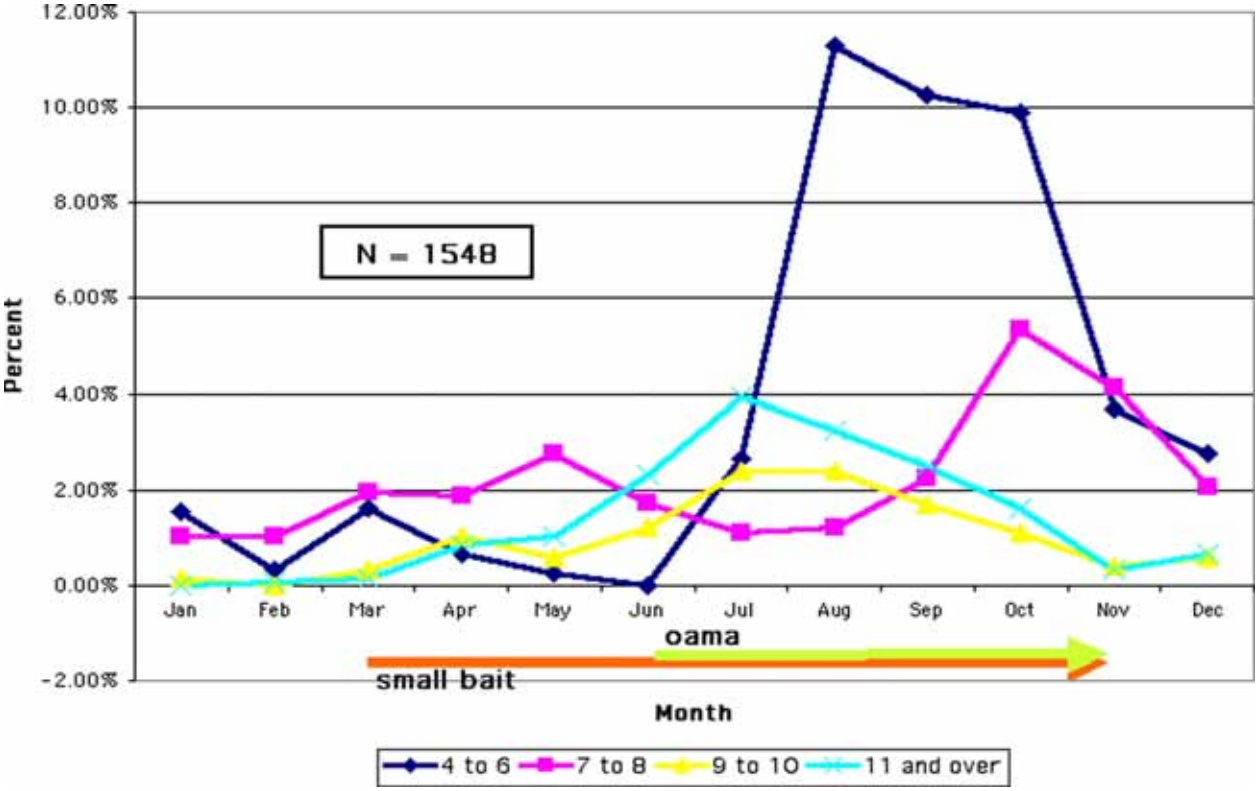


Figure 10b. Percentages of Omilu by Size Class per Month During 2003

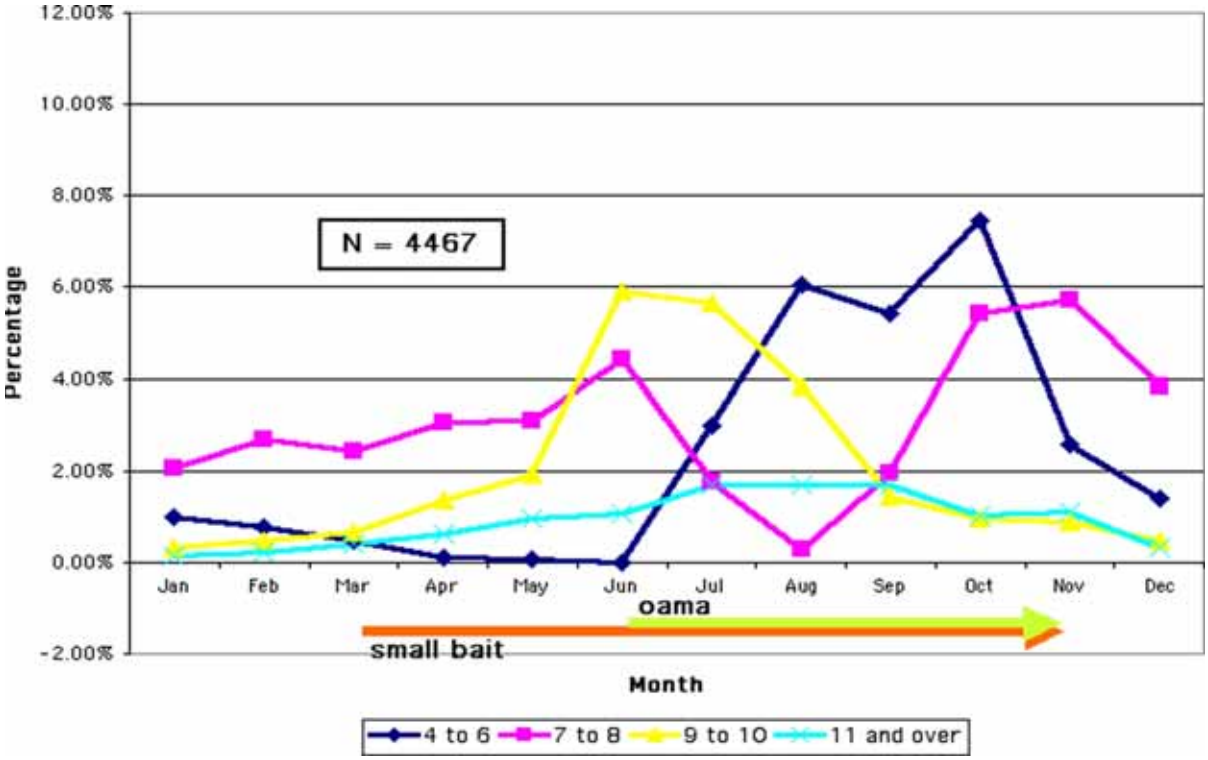
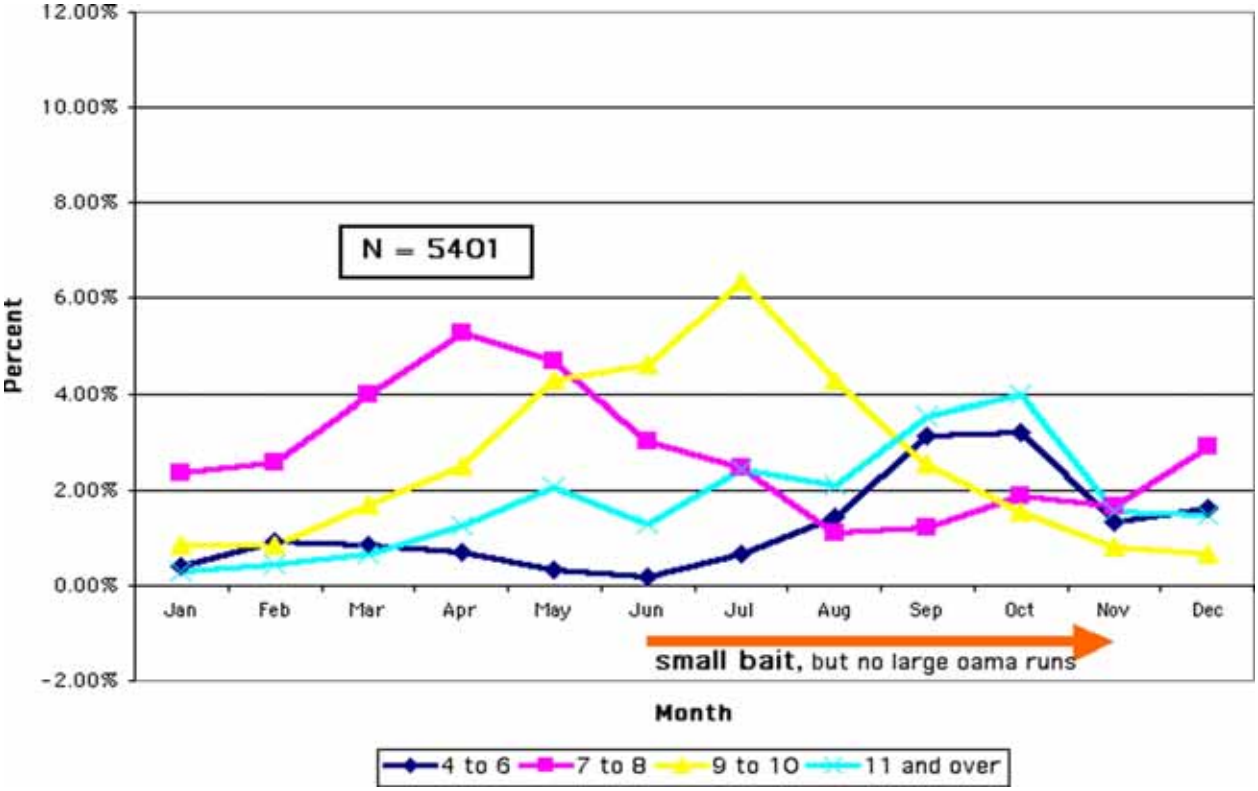


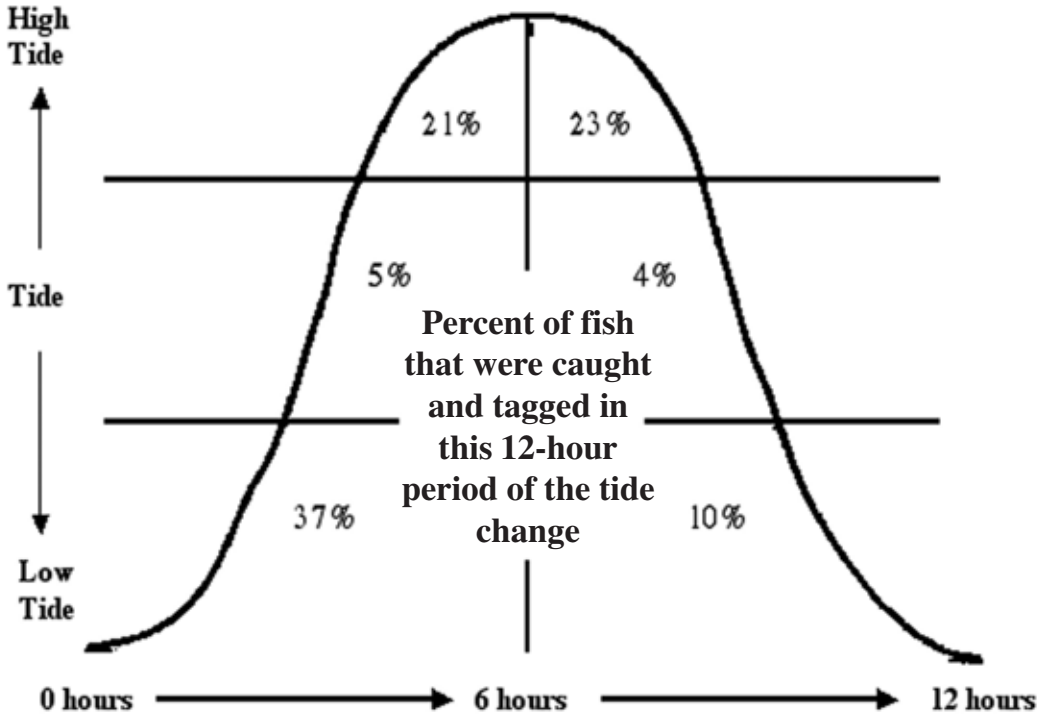
Figure 10c. Percentages of Omilu by Size Class per Month During 2004



TIDAL INFLUENCE ON FEEDING PATTERNS

The time of day on each tag and/or recovery effort is recorded as part of the data collected. Based on this information, the time of day can be matched with the tidal changes taken from a local tide chart. Each fisherman has their own theory on when and where the fish will bite (be caught on a hook and line). Tag and recovery data from 531 omilu caught in the Kakaako area on Oahu were analyzed for correlations between the feeding habits of the omilu with corresponding moon and tide phases. Feeding habits of the juvenile omilu did not appear related to moon phases. However, it is more well known among fishermen that the moon phase plays a big role in determining when to fish for the larger adult jacks. There was a relationship between when the fish were caught and the corresponding tide phase (see Figure 11). Results were based on an average of six hours be-

Figure 11. Number of Fish Caught and Released during Two-hour Periods of the Tide



tween peak low and peak high tides. These were further broken down into three, two-hour intervals to determine how many fish were caught at each interval. Results indicate that 37% of the bites (197 catches) occurred on the low and beginnings of rising tides (0 to 2-hour interval). As the tide moved into the 2 to 4 hour interval, bites were sparse with only 5% (28 catches) occurring at the mid tide. The 4 to 6 hour and 6 to 8 hour intervals were extremely productive producing 44% (230 catches) of the bites. During the mid-falling tide at the 8 to 10 hour interval, bites were again sparse with only 4% (23) of the fish caught. The last interval at the 10 to 12 hour mark produced 10% (53 catches) of the bite. It is not known what the significance of the tide is with regard to feeding. Perhaps tidal changes cause disturbances along the bottom churning up sand and various substrate

material exposing additional food sources for predator fish such as the omilu. Rising water depth may also provide access to more feeding areas. Further investigation is needed.

EFFECT OF AN INCREASE IN MINIMUM SIZE REGULATION

The minimum size for take of all papio increased from 7" TL to 10" FL as of 12/19/02. In 2003 there was a noticeable increase in the numbers of 9" to 10" FL omilu being tagged. At the same time there was an increase in volunteer anglers which caused an increase in effort. To reduce the bias from an increase in tagging effort, the percentage of 9" to 10" FL omilu out of the total number of omilu tagged was looked at to determine if there was a noticeable increase in the numbers of 9" to 10" FL Omilu.

Figure 12. Yearly Percent of the Total Tag and Release Catch of 9 to 10-inch FL Omilu

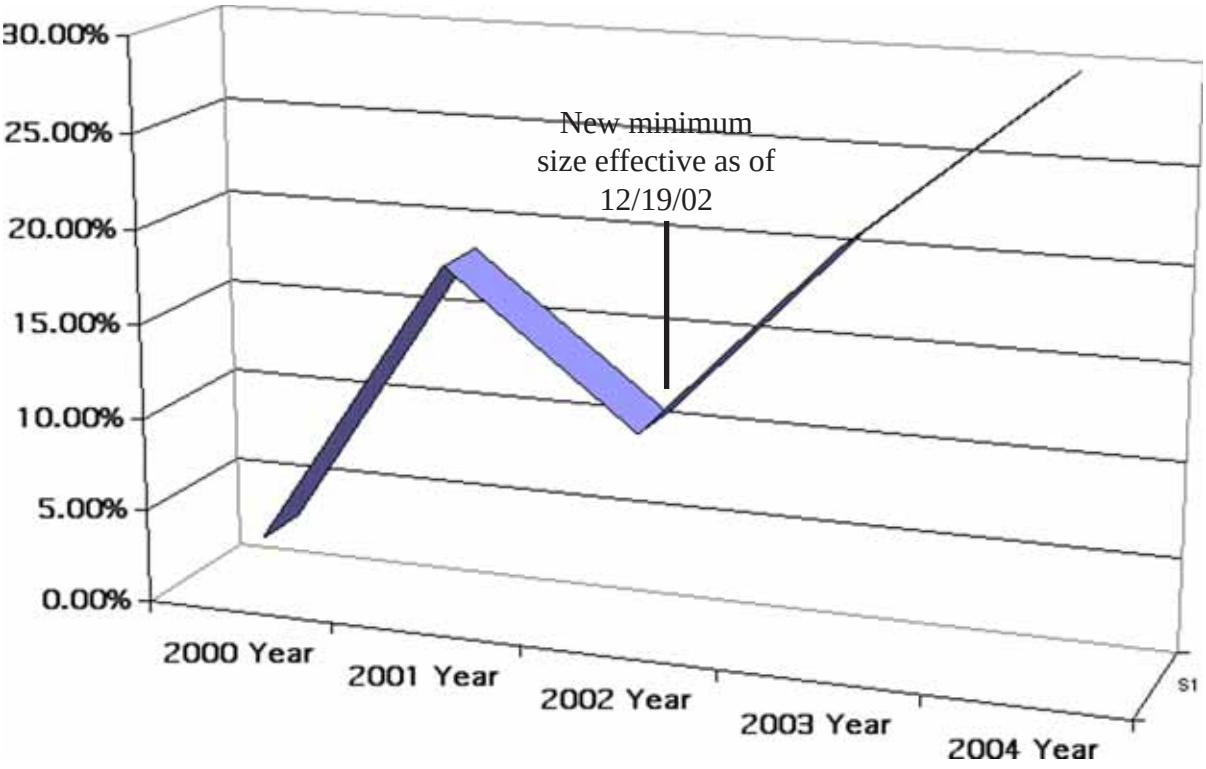


Figure 12 indicates that there was a measurable increase in the percentage of fish tagged and released in the 9" to 10" FL size range since the minimum size change took effect. A combination of factors may have contributed to this increase in 9" to 10" FL sized fish being caught, one of which may include the new minimum size. Other factors could have also played a role in this increase including successful recruitment years, successful recruitment of prey/bait items, or even an increase in the overall effort of fishermen practicing catch and release methods. The 9" to 10" FL size is also the size at which the omilu will begin to travel. They will begin to spread out as they travel increasing their chances of survival and decreasing the likelihood of being caught as easily.

DISCUSSION

Tag and recovery data preliminarily indicate the omilu resources in the Main Hawaiian Islands appear to be at a sustainable level. Current fishing pressure does not seem to be affecting the omilu population, as there appears to be a healthy recruitment of juveniles annually as long as the habitat and food resources remain available. Annual recruitments of juvenile omilu indicate that there are sufficient numbers of spawning adults to support a papio fishery for this species.

However, there is much sentiment among anglers of all fishing communities that the omilu fishery is not quite the same as it used to be. Many anglers remember when there were larger and more individuals being caught per angler as recently as 3 decades ago. Within 3 decades island populations have increased 50% growing from about 800,000 to over 1.2 million people. Assuming the total population of omilu has not increased over time, this number divided by more anglers would equal a lesser number of fish caught per angler.

Increases in population bring more development and urbanization and all the accompanying impacts to our nearshore areas. Land development can produce changes in nearshore habitats by altering land areas and natural stream channels causing erosion, sedimentation and nutrient runoff. Increases in polluted runoff have been linked to a loss of aquatic species diversity and abundance, including many important commercial and recreational fish species (NOAA 2003). These changes could also affect estuarine areas that provide nursery habitats and protection for the omilu. As island populations continue to grow, the Ulua Tagging Project can continue to help monitor current trends on the omilu fishery.

The present condition of our ulua and papio resources is probably influenced by a combination of the above named factors, which is related to an increase in our island populations as a whole. A study done in Switzerland investigating the decline in inland fish catches lends support to this, concluding that a single factor is not responsible for the widespread catch decline; rather, a combination of stressors contributes to the observed negative effects (Burkhardt-Holm et al., 2005). Anglers are doing their part in taking responsibility to conserve our limited fishery resources by following the current minimum size regulations and bag limits that are set for the ulua and papio.

When the minimum size for take of all papio increased from 7” TL to 10” FL in 12/19/02, there was a noticeable increase in the numbers of 9” to 10” FL omilu being tagged in 2003 (Figure 12). As an added benefit, catch and release methods are becoming more commonplace along the shoreline due to anglers’ interests in information obtained through the tagging project on omilu growth and movement as well as monitoring of the resource. Volunteer anglers are assisting the Division with collecting data on the omilu resources, which will allow us to update the current management regimen step by step.

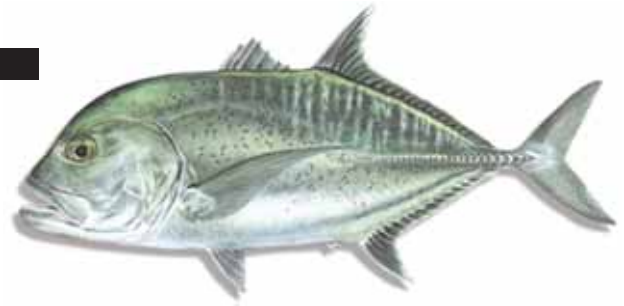
With the communities’ help, the Division will continue to assist the anglers with sustaining their omilu resources by monitoring the omilu fishery through tag and recapture data to assess the condition of the omilu resources in Hawaii. Before deciding on what management strategy or combination of management strategies to apply toward revising our current regimen for the omilu resources, we need to conduct a stock assessment for this species. The tagging project has been

instrumental in providing the first sets of data needed to begin a stock assessment analysis for the omilu. The stock assessment would enable us to estimate numbers on what the total omilu population may be, recruitment rates, mortality rates, exploitation rates, etc. This would help us determine whether or not the omilu resources are currently being fished sustainably.

We also need to consider additonal factors that influence the omilu resources such as ocean current patterns, climatic conditions, available habitat and sufficient food sources which play an important role in the recruitment, growth, and dispersal of omilu. We will also need more tag and recapture information for the subadult and adult populations for this species. Along with community input, all of this information combined will help us to determine the best most appropriate management options possible to sustain our omilu resources.

White Ulua, Giant Trevally

Caranx ignobilis



The giant trevally or white ulua is widely considered to be the ultimate shoreline gamefish. Reaching lengths over 5 feet and weights close to 200 lbs., an entire industry based on the fishing gear alone revolves around this fishery.

Tagging data reflects that prior to August 2002, white ulua and papio occurred in small numbers (11 to 138 total tagged in 2000 & 2001 consecutively) along the shoreline. However, in August 2002, there was a large recruitment of this species along the shoreline on Oahu with 1347 total being tagged in 2002. This abundant trend continues in 2003 with 1189 White Ulua/Papio tagged and in 2004 with 1961 white ulua and papio tagged. It is unknown whether the current recruit classes are a normal or unusual phenomenon. Continued tag and release data should reveal over time if this is part of a natural cycle or not.

WHITE PAPIO RECRUITMENT

Tag and release data indicate that the earliest recruits of the year are the 4" to 5" FL white papio that are first noticed along the shoreline between the months of August to November with peak recruitments occurring between September and October. White papio are juvenile giant trevally that are less than 10 lbs. in weight or less than 25" FL.

White papio measuring 2" to 3" FL are sometimes seen along the shoreline, but they noticeably begin to enter the fishery at 5" FL. By the time they reach 6" FL, it appears that the majority of the white papio have entered the fishery, as indicated by the large percentage being tagged (see Figures. 13a,b & c).

In general, high numbers of white papio do not occur every year as the omilu does. However, 2002 was an extraordinary year for white papio where numbers higher than what was seen in previous years were reported for this species. It is too early to tell if large recruitments like this are part of a multi-year cycle or if this is something that was unusual. Factors that may influence recruitment include a successful spawn from the previous year, high survival rates of juveniles, or climatic conditions such as an El Nino which can affect ocean conditions and current patterns that may influence recruitment.

White papio exhibit an affinity for areas that have some freshwater influences from streams, springs, or other sources. The Ala Wai Canal, which drains the Manoa and Palolo watersheds, appears to be a prime nursery ground for the white papio on Oahu. In general, juveniles ranging in size from 6" to 9" FL were found to inhabit the Ala Wai Canal. At 9 inches fork length, recovery data indicates

Fig. 13a. 2002 White Papio Recruitment

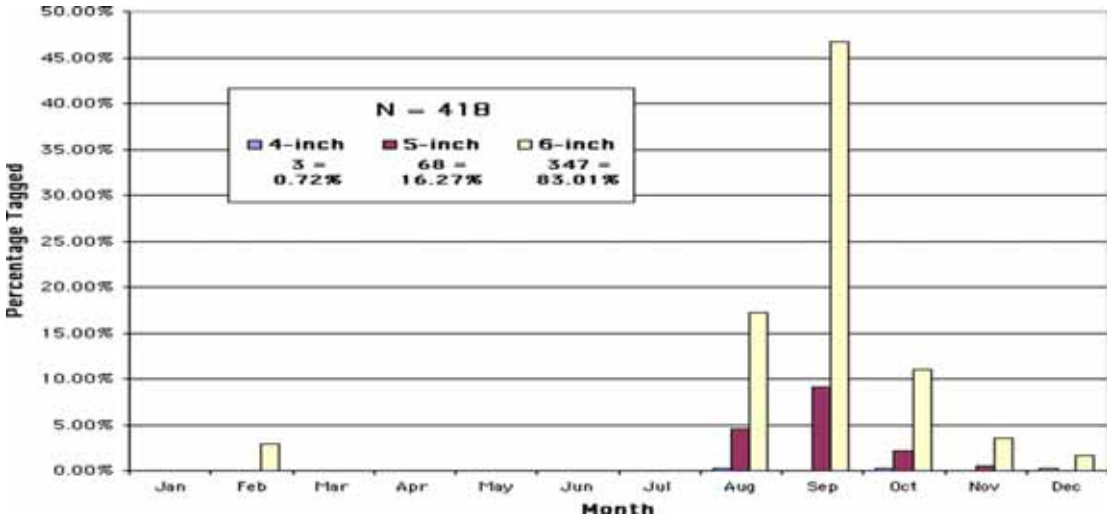


Fig. 13b. 2003 White Papio Recruitment

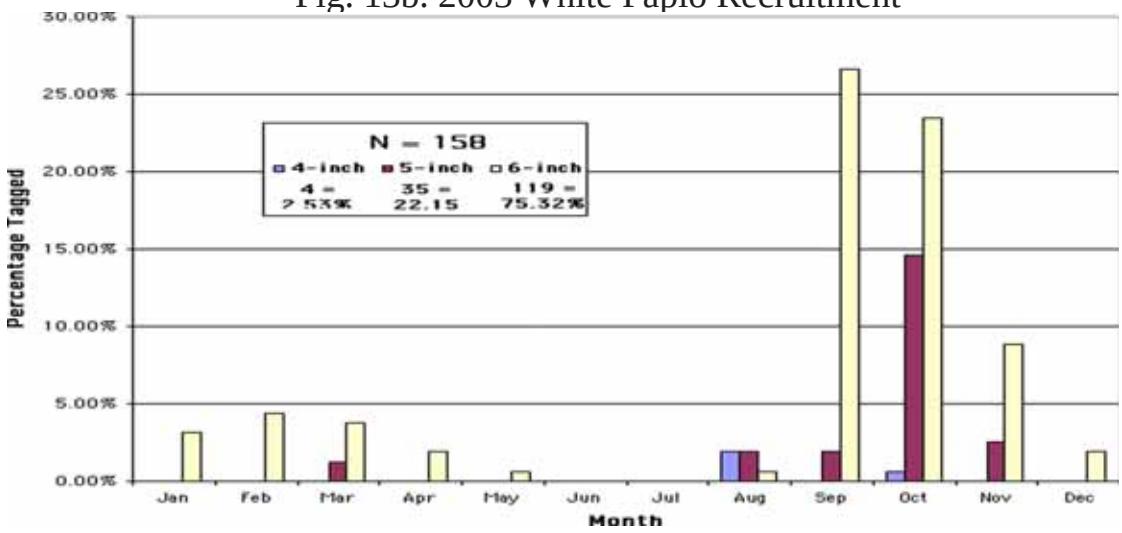
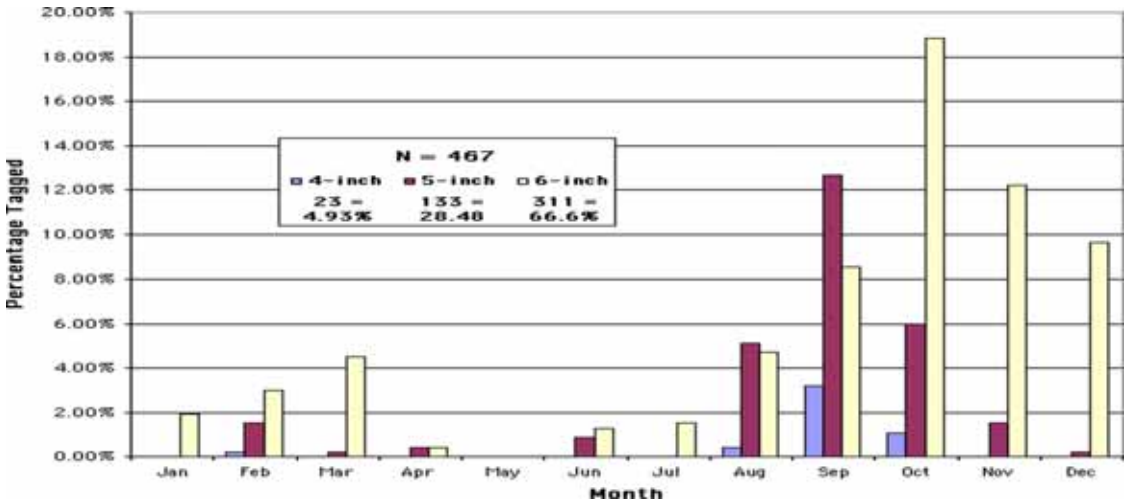


Fig. 13c. 2004 White Papio Recruitment

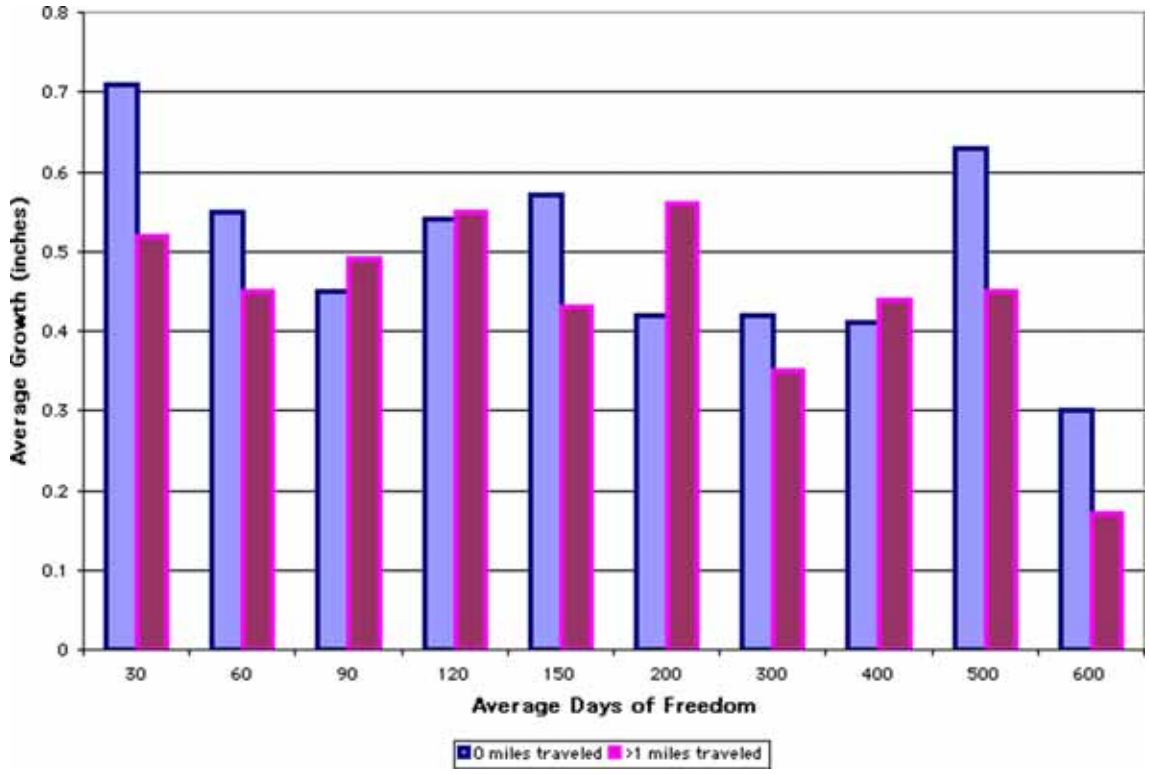


that these fish slowly migrate out of the canal and distribute themselves along the entire Oahu shoreline ranging in areas from Waikiki Beach to Hickam Harbor and beyond. Based on their growth rate within the Ala Wai Canal, a 6-inch FL fish will spend between 1-1/2 to 2 months in the Ala Wai Canal before leaving the Canal.

GROWTH

As with the omilu, growth rates for the white papio are based on recaptured fish that were at liberty between 14 to 45 days averaging 30 days of freedom. It also appears that in general, white papio that were tagged and recaptured in the same area have higher growth rates than those that were recaptured 2+ miles away from the original area tagged (See Figure 14). This indicates that traveling may affect the white papio's growth rates as it does with the omilu.

Figure 14. Comparison of Average Monthly Growth in Stationary vs. Traveling White Papio

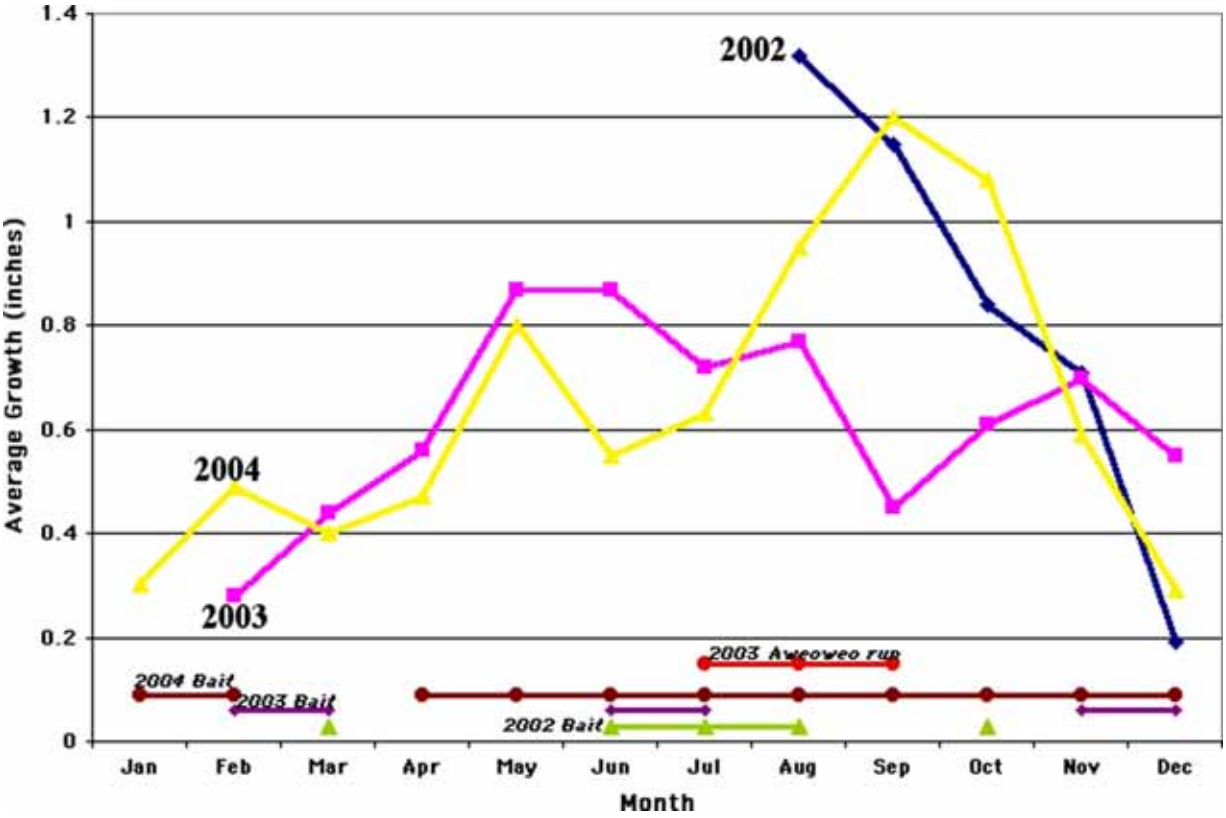


Some preliminary information indicates that white papio on the leeward side of the Island of Oahu exhibit very minimal growth. A primary example is a 12-inch white papio that was tagged off the coast of Waianae on the Island of Oahu and recovered one year later in the same place at the same size. The leeward side of each Island is much drier with less stream flow and rainfall than the windward side. There is speculation that without the freshwater flowing into the ocean, there are very few estuarine areas that would provide habitat and nursery grounds for bait fish, juvenile reef fish and various invertebrates that would provide food sources for the papio. More studies are needed to determine what factors may contribute to a white papio's lack of growth in leeward areas.

Juvenile growth

The white papio exhibit even faster growth spurts than the omilu. Figure 15 illustrates the average growth rate per month of White Papio ranging in size from 5 to 15 inches in FL in the years 2002 to 2004. Monthly growth rates of white papio may be related to the availability of certain prey. It appears that white papio from 4" to 9" FL inhabit the estuarine areas where prey items are found. At approximately 9.5" FL, they will feed on larger bait items such as the introduced gold spot herring, *Herklotsichthys quadrimaculatus*. Also known locally as sardines, these are commonly used by fishermen for bait in catching white papio that are 9" FL or larger. White papio will also feed on the halalu (juvenile akule), *Selar crumenopthalmus*, when available, but white papio are particularly associated with feeding upon the gold spot herring schools. During the summer, white papio in the 5" to 15" FL size range can grow 1 to 2 inches per month. As the food supply subsides toward the end of the year, average growth rates can drop to about 0.2 inches per month by Decem-

Figure 15. Average Monthly Growth Rates of White Papio at 5 to 15 inches FL



ber. Summer growth rates for white papio in 2003 appeared to be lower than what was seen previously. During this time period (July to September 2003) there was also an unusually large recruitment of aweoweo, *Priancanthus meeki* (Appendix D). There may be some relationship between the large recruitment of aweoweo and the slower growth rates of the white papio. Papio growth rates decreased when the aweoweo numbers increased and increased after the aweoweo numbers subsided. However, it is unclear what the relationship is between white papio growth rates and the abundance of aweoweo. Competition for the same food source along with other factors such as

unusual current patterns or low recruitment of prey items may have also contributed to this slow growth rate. Toward the end of 2003, the growth rate appeared to be steady at 0.5 inches per month indicating that some type of food source was available for these fish at that time. 2004 was unusual in that food was reportedly available almost all year long which reflected steady increasing growth rates peaking at an average 1.2 inches per month in September. As the food sources subsided, growth rates were down to 0.3 inches per month by December, close to what was seen previously during December 2002.

Adult growth

Sexual maturity occurs in this species at approximately 23.6 inches standard length at 3.6 years of age (Sudekum et al., 1991). Fish at this size are considered to be adults and are classified as ulua. As of December 2004, 178 fish measuring 23.6" FL and larger were tagged. Out of these, volunteer anglers recaptured 14. It appears that the growth rate for this species also slows down once the fish are mature. The size ranges of these fish when they were recaptured range from 25.9 inches to 51 inches fork length with an average growth rate of 1 inch per year and average days of freedom set at 313 days (11 to 765 range). Since white ulua are highly prized by many fishermen, very few are tagged and released. As the majority of tagged white papio increase in size and age eventually reaching sexual maturity, it is expected that more information on adult growth will be obtained.

MOVEMENT/MIGRATION

Similar to the omilu, the white papio follow the same general clockwise and counterclockwise movement patterns around each island (See Movement/Migration on Pages 11 to 15). However, the white papio seems to travel farther than the omilu averaging a distance of 5.4 miles from the original area tagged and released as compared to 1.12 miles respectively.

SIZE CLASS DISTRIBUTION

Based on short-term recoveries,white papio also appear to remain within the same area until they reach approximately 9.5" FL. At this size, recapture data indicate they begin to leave the area. Fish at 9.5" FL are at the lower end of the size range of white papio that are caught by fishermen using sardines for bait. Sardines are normally found along the outer edges of estuarine areas. Movement of 9.5" FL fish from the estuary may indicate that they are beginning to forage for a wider range of food items.

Figures 16a,b & c illustrate the percentages of the different size classes of *C. ignobilis* as they are caught and tagged along the shoreline from 2002 to 2004. Prior to 2002, *C. ignobilis* was caught in very low numbers. As stated previously, 2002 saw a surge in the recruitment of white papio that surprised a lot of fishermen who haven't seen large numbers of white papio for quite some time. The 2002 recruit class contributed toward the increase in the appearance of fish in the larger size classes along the shoreline in 2003.

Similar to the omilu, there is also an indication from the data of a general distribution pattern of

Figure 16a. Percentages of White Papio by Size Class per Month During 2002

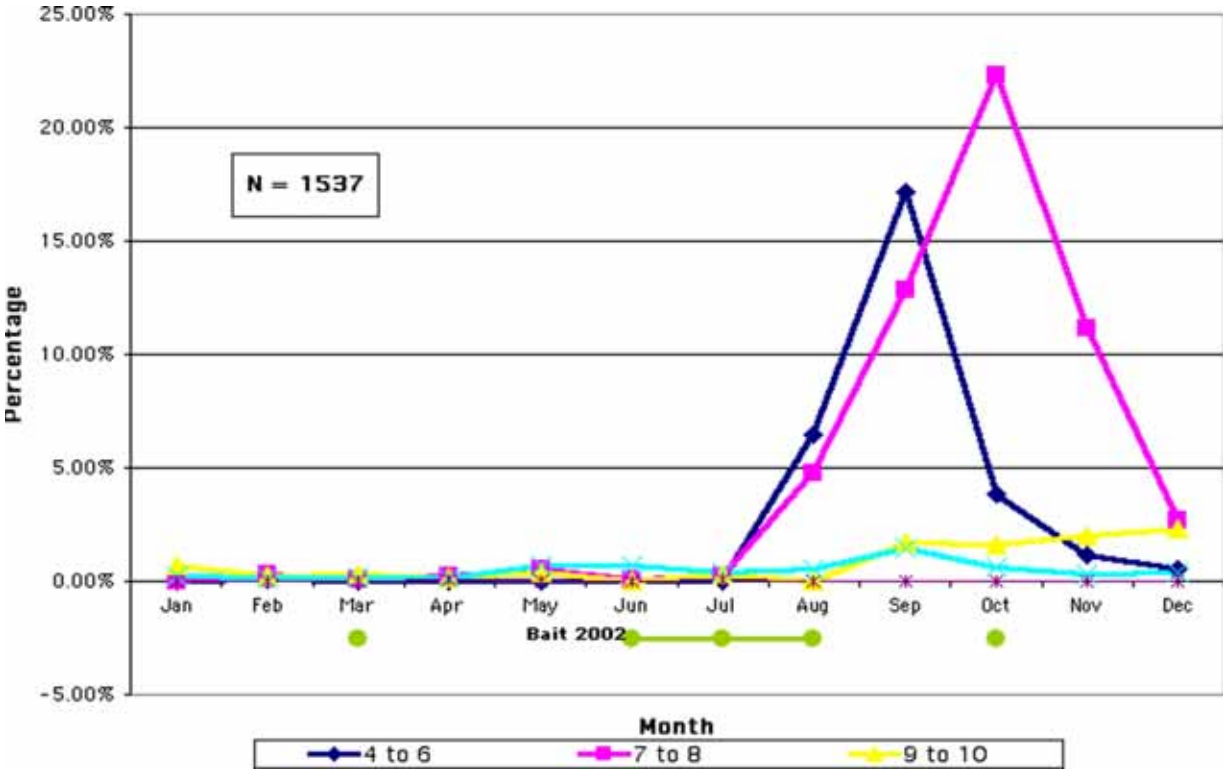


Figure 16b. Percentages of White Papio by Size Class per Month During 2003

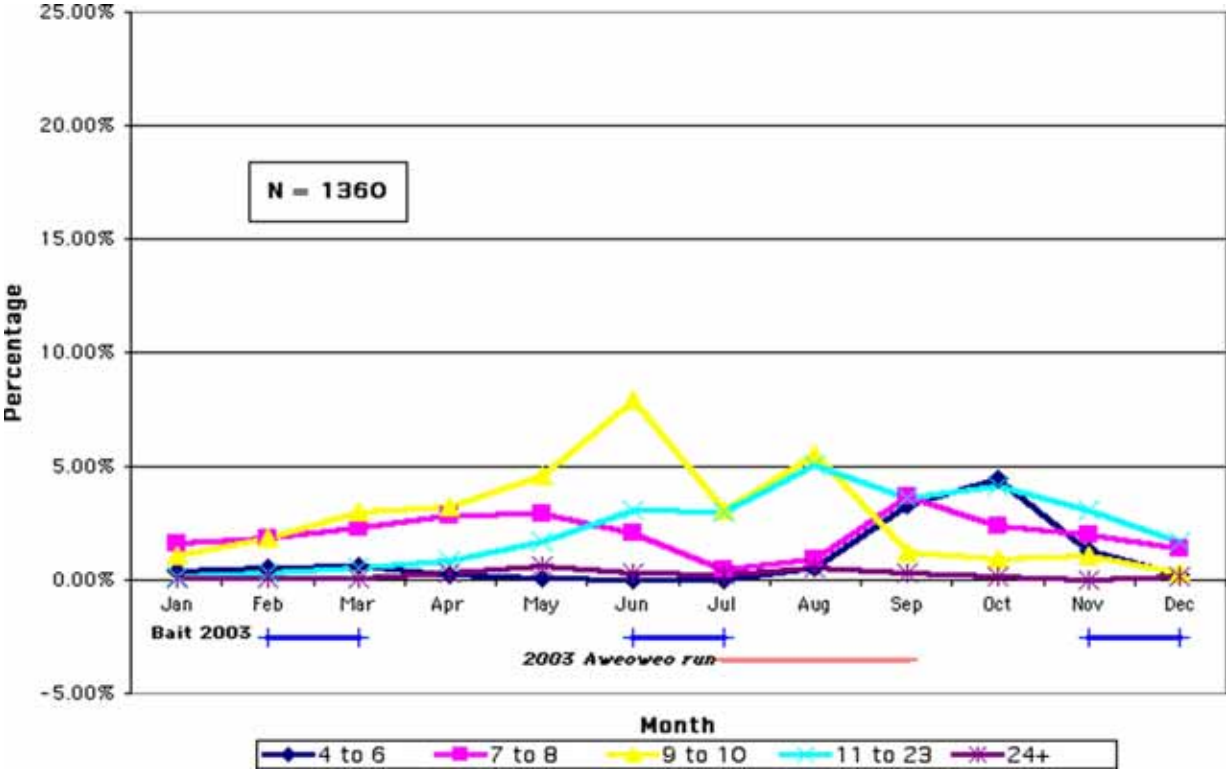
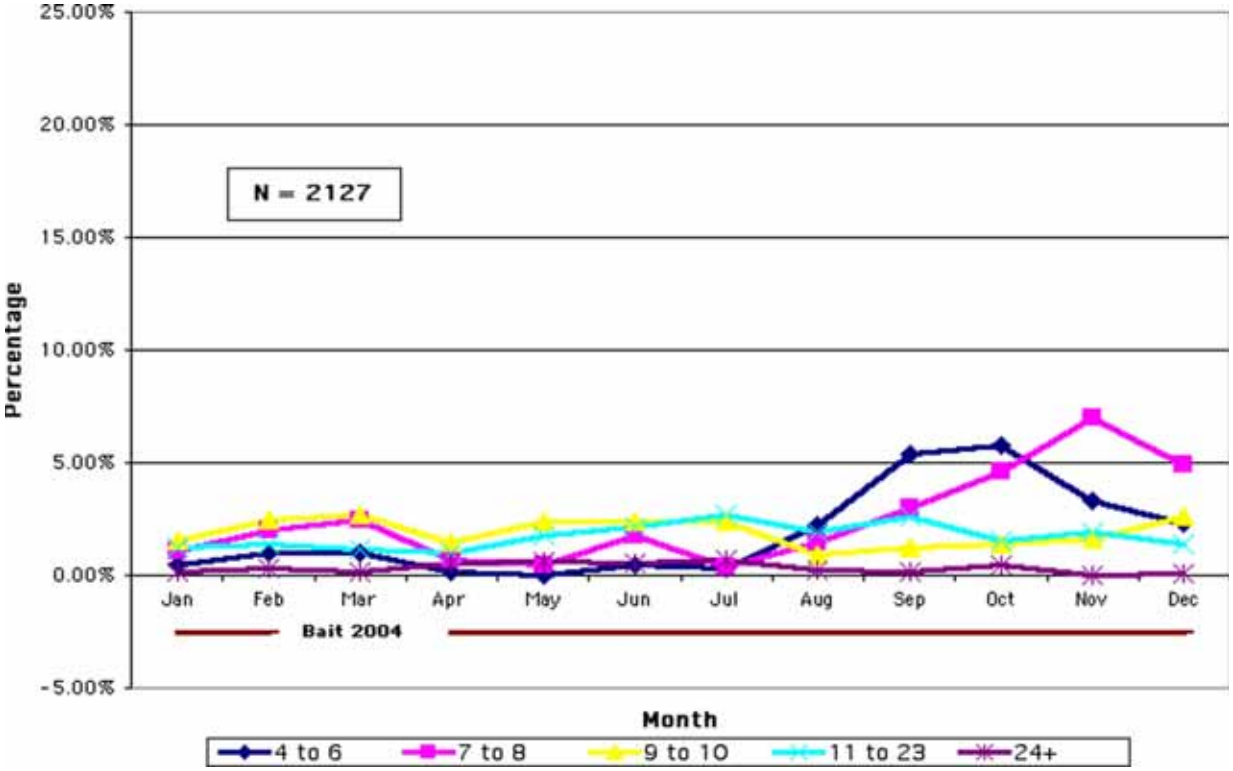


Figure 16c. Percentages of White Papio by Size Class per Month During 2004



smaller white papio inhabiting inshore areas and larger white papio and white ulua are being caught further offshore (see Figure 17). Like the omilu, some of the white papio measuring over 9.5" FL may remain inshore as long as there is an available food source. Once the food source dwindles and is gone, these larger fish will begin to move out of the area foraging for more food. Data indicates that the majority of fish remaining in the area measure less than 9.5" FL. We think that these fish remain in the area because at less than 9.5" FL, they may be more vulnerable to predators if they leave the area on their own. Growth data during the months when food sources appear low suggest there may be enough food in the area for the smaller fish. Monthly growth rates of 0.5" or less indicate that there are some food sources in the area for fish less than 9.5" FL, but perhaps not enough to maintain fish larger than 9.5" FL. More studies on dietary habits are needed to confirm this.

As for the larger fish, there have been observations of schools of ulua-sized fish (10 lbs. and larger) occurring in deeper waters further offshore based on reports by commercial and recreational fishermen. Up until the mid 1980's, an offshore surround net fishery existed specifically for the white ulua. This fishery selectively targeted white ulua and white papio that were between 1 lb. to 30 lbs. in size range which was considered the optimal sizes to obtain best market values. Fishermen purposely did not target the larger "gorilla" sized white ulua (over 30 lbs. in size) because these larger fish had very little market value and their fishing nets and equipment were badly damaged and destroyed in the process due to the size and strength of these larger animals. The surround net fishery targeting schools of large ulua came to a halt in the mid 1980's due to public health and safety issues over high incidences of ciguatera fish poisoning and liability concerns by fish dealers (personal comm., Brooks Takenaka 2006).

Figure 17. General Size Distribution of White Ulua/Papio by Depth

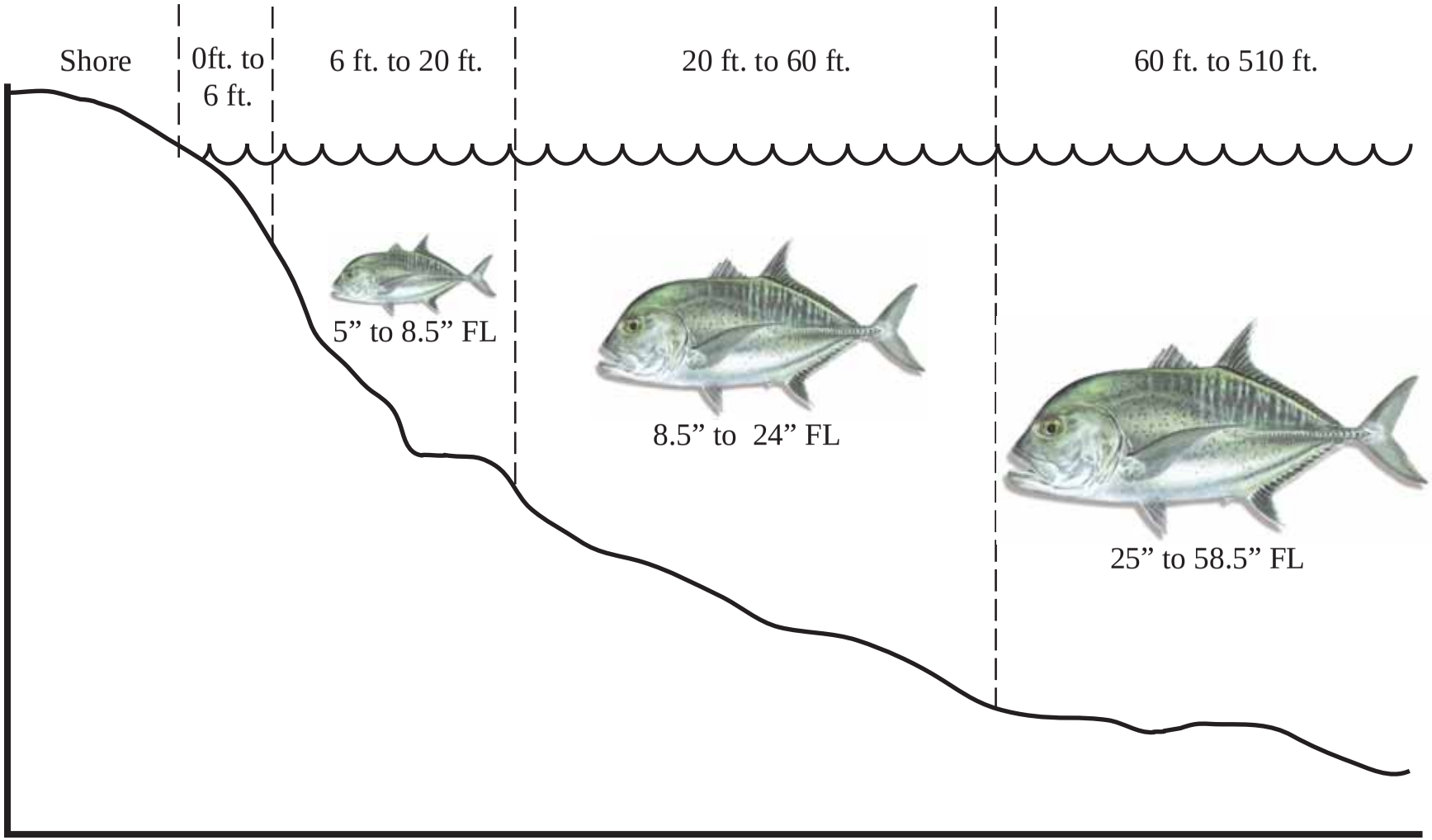
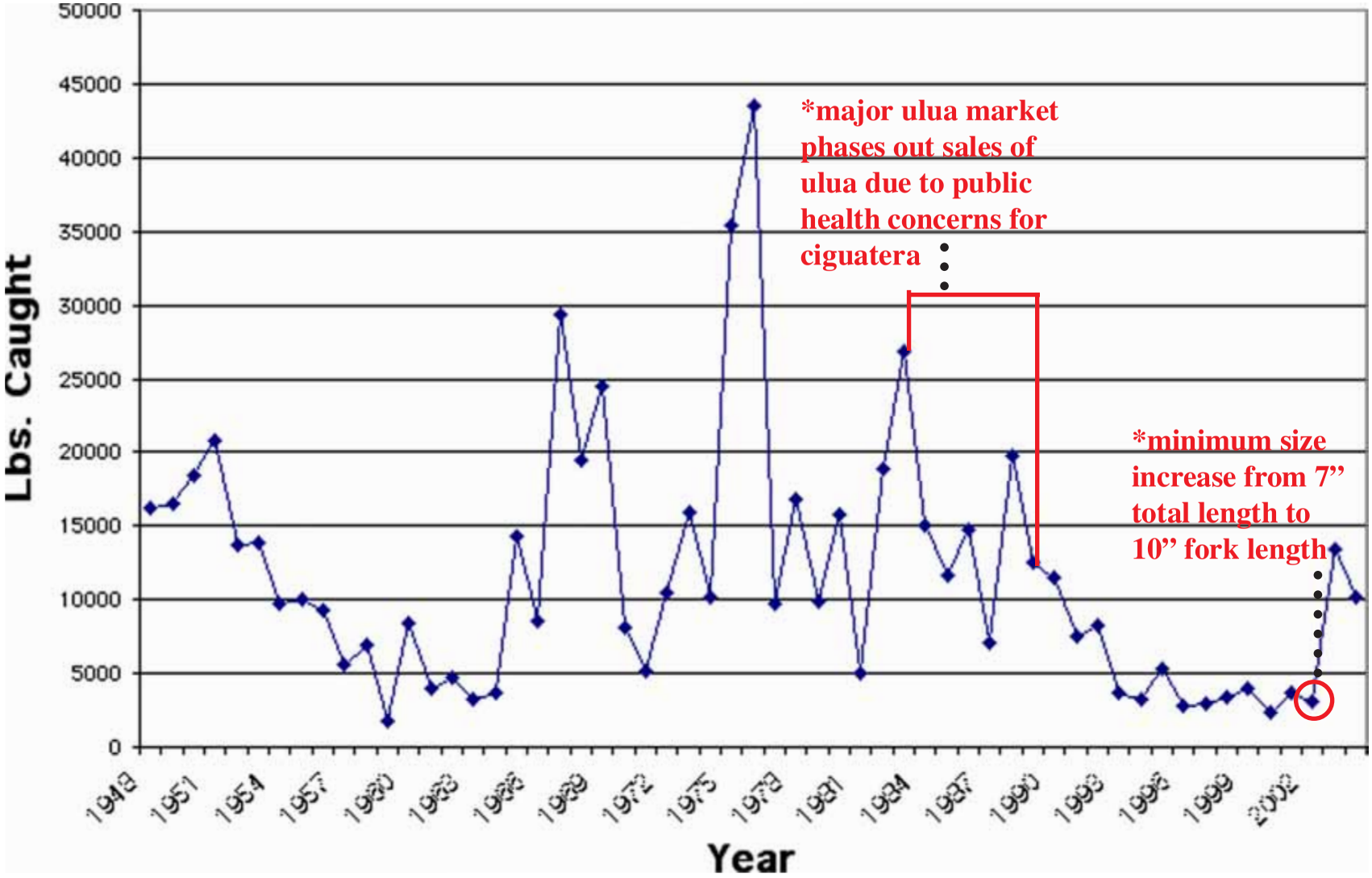


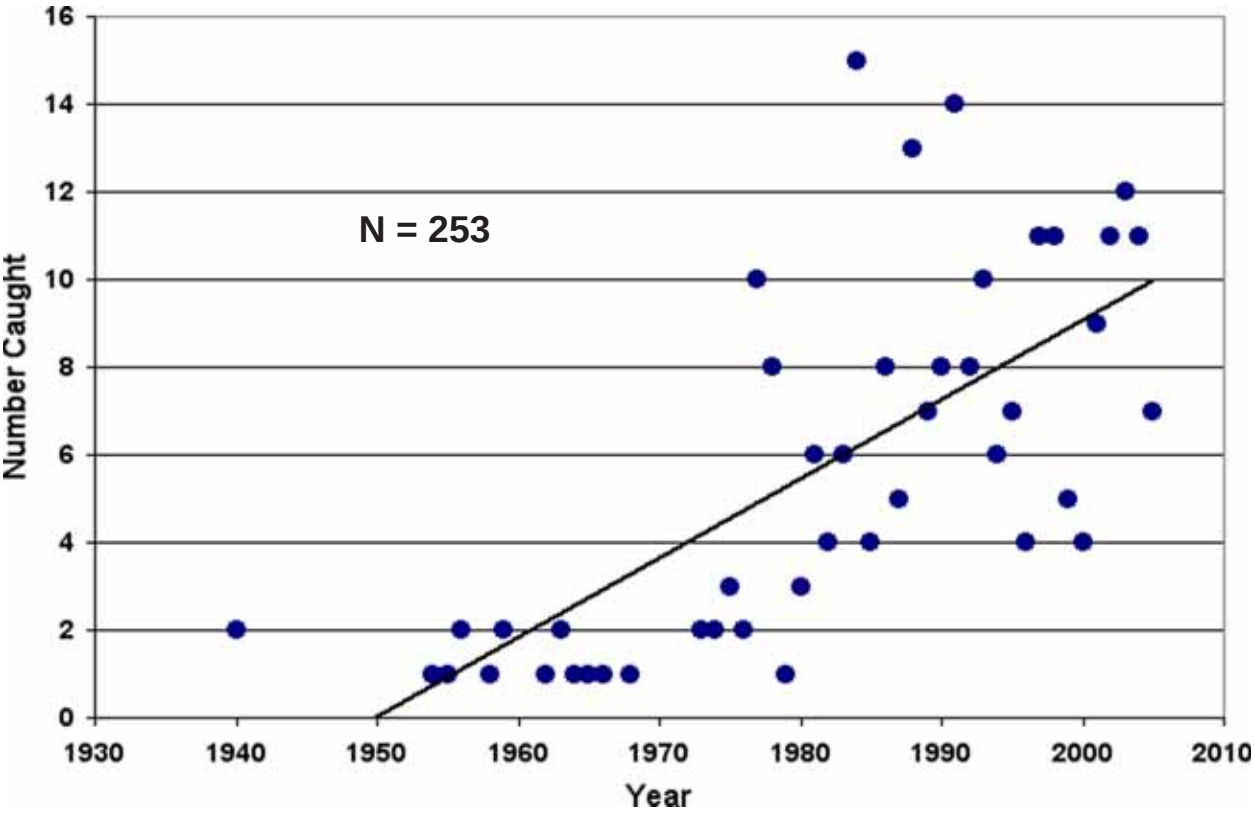
Figure 18a. Commercial Net Landings of Jacks, MHI Areas Only, 1948 - 2004



In the early 1980's the largest fish dealer in the State of Hawaii, United Fishing Agency, stopped accepting and selling ulua, kahala and other reef fish from the Main Hawaiian Islands due to liability concerns from ciguatera poisoning (personal comm., Brooks Takenaka 2006.). With the major market for ulua and kahala closed, many fishermen stopped fishing for the white ulua and kahala. This caused a major decrease in the commercial net landings reported for the ulua fishery, which is often misinterpreted as a decline in abundance (Figure 18a).

As a result of this market collapse, the ulua schools in the Main Hawaiian Islands have remained largely untouched. Since then, there have been steady reports of offshore sightings of massive schools of white ulua reported in the Main Hawaiian Islands by commercial and other fishermen. Perhaps this has contributed to the recent numbers of 100+ lbs. white ulua being caught as referenced in the 100-Plus Club of the local fishing publication Hawaii Fishing News (Figure 18b, Hawaii Fishing News 2005b).

Figure 18b. Trendline for Numbers of White Ulua (100 lbs. and larger) Caught and Registered Annually in the 100-Plus Club, Hawaii Fishing News



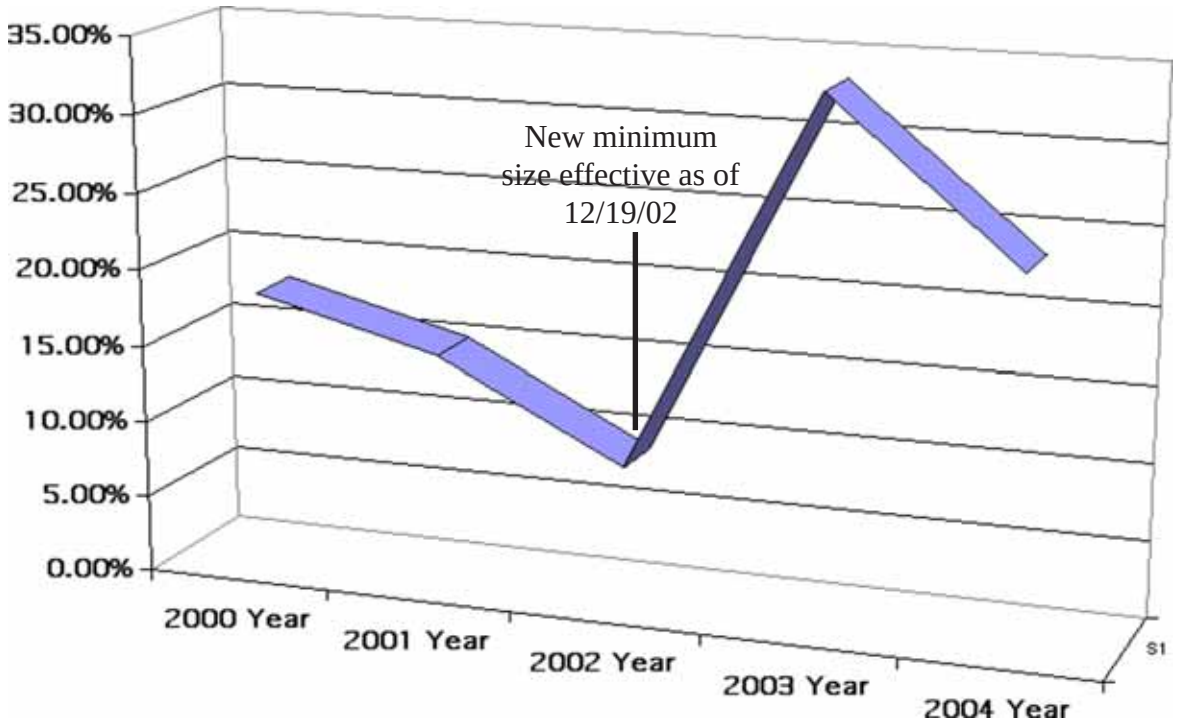
The market for the smaller 1 lb. to 3 lbs. size white and other papio has remained constant. As of 2003, the minimum size regulation for the sale of papio was increased to 16" FL (approximately 3 lbs.). For the consumer, the 16" FL size fish is less desirable than the 11" to 14" size papio (1 lb. to 2 lbs. respectively) because the 11" to 14" size fish provides the approximate market serving portions for 1 to 2 people (personal comm., Brooks Takenaka 2006). According to gill net fishermen, targeting the 3 lbs. size papio is very difficult since the schools are often mixed with smaller under-

sized and larger less marketable sized papio. For these reasons, the consensus amongst fishermen is that ulua/papio net fishermen are gradually giving up targeting the ulua and papio species altogether. Perhaps this has contributed to the increase in the number of larger papio (10" FL and larger) being tagged and released along the shoreline (Figure 19).

EFFECT OF AN INCREASE IN MINIMUM SIZE REGULATION

After the considerably large recruitment of juvenile white papio in the latter part of 2002, there appeared to be an increase in the numbers of 9" to 10" FL white papio being caught and tagged. Figure 19 indicates the percentage of 9" to 10" FL white papio out of the total number of white papio that were tagged per calendar year. As with the omilu, there was also a noticeable increase of 9" to 10" FL white papio being caught after 2002. An increase in the minimum size regulation at the end of 2002 may have contributed in part to this increase in numbers along with the large recruitment of white papio in 2002 along with a number of other factors. Continued monitoring through tag and recapture data will be able to give us an idea if this trend will continue or not.

Figure 19. Yearly Percent of the Total Tag and Release Catch of 9 to 10-inch FL White Papio



DISCUSSION

White ulua, are considered one of the most prized species of jacks occurring within the Main Hawaiian Islands. Fish weighing 100 lbs. and larger are highly targeted by recreational fishermen.

This fishery is so highly specialized that Hawaii has led the way in tackle development for this species. Everything from high tech poles made of exotic composites to custom alarm bells known locally as "gata gata bells" to alarm and signal a strike were created. This fishery alone has created a small industry of wholesale and retail tackle businesses throughout the island chain as well as having spawned many shoreline tournaments that specifically target this species.

As with the omilu, local anglers have expressed concern that certain sectors of the white ulua and papio fishery have experienced a decline over the years. Part of this can be attributed to some of the same impacts that have affected the omilu resources (see Omilu DISCUSSION section). Increasing island populations along with all the attendant impacts that follow with urbanization and land development not only affects the ulua and papio fishery but impacts all the other nearshore fisheries as well. In addition, these impacts also affect nursery habitats particularly critical for this species that are highly dependent upon the availability of freshwater that enters the sea to form the estuarine environments that provide food and protection for the juvenile white papio.

Project data has documented a large recruitment of juvenile white papio in 2002. It is unclear as to whether this large recruitment was an anomaly or whether it may be cyclic in nature especially since the numbers of white ulua and papio reportedly caught and tagged for 2000 and 2001 were very low. Tag and recovery data for 2003 and 2004 has shown that the 2002 recruitment has added to the white ulua and papio population resulting in higher numbers of several size classes being caught along the shoreline. Combined with the increase in minimum size during 2002, this may have contributed to the increase in 9" to 10" FL white papio being tagged and released along the shoreline (Figure 19). The Ulua Tagging Project will continue to help monitor this fishery to see if it continues to produce more 9" to 10" FL fish in nearshore areas.

The current management regimen for this species consists of the same minimum size for take and bag limits that apply for the omilu and all the other ulua and papio species. It is highly recommended to consider having the white ulua and papio managed separately from the other ulua and papio species due to its large size and length of time required to reach sexual maturity. In addition, its high desirability as a sport fish along with the specialized fishery that exists for this species lends more of a need to consider separate and/or additional management strategies for the white ulua and papio.

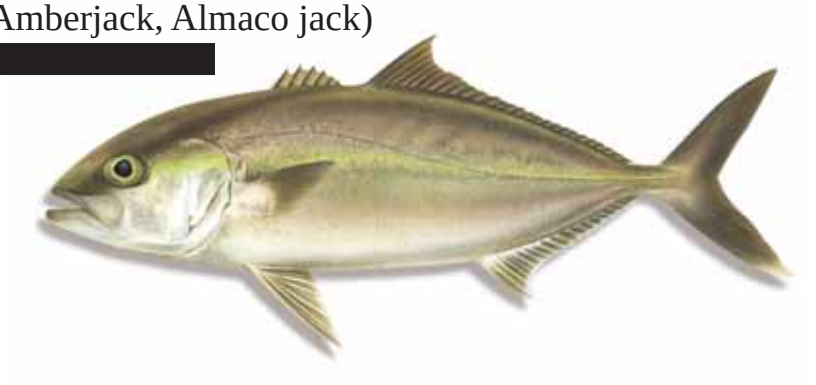
It is too premature to tell from the tagging data if the white ulua and papio resources in the Main Hawaiian Islands appear to be at a sustainable level. A stock assessment analysis needs to be done for this species to estimate values for total population, mortality rates, recruitment rates, etc., to determine whether this species is being fished sustainably. These estimates will also help us to determine what management tools are needed to help maintain this resource for sustainable use. A stock assessment analysis requires a minimum 5 years of tag and recapture data. As of December 2004, we have 2 years of data and intend to collect the additional 3 years needed to begin a stock assessment analysis for this species.

Recruitment, growth, and dispersal for the white ulua and papio are highly dependent upon sufficient food sources, ocean current patterns, climatic conditions and available habitat. Continued tag and recovery efforts for all size classes of white ulua and papio will help us more closely monitor

how these factors affect and influence the fishery. In addition, more tag and recapture information for the subadult and adult populations of white ulua and papio is needed to obtain data for an assessment on this sector of the population. All of the above information combined with community input will help us to determine the best management strategies that would be the most effective to help sustain the white ulua and papio resources.

Kahala, Amberjack (Greater Amberjack, Almaco jack)

Seriola dumerili
Seriola rivoliana



Two species of kahala are being tagged by volunteer anglers. Kahala has been included as one of the target species for tag and release because this fishery has remained unexploited since there has been a voluntary moratorium on the sale of these fish due to concerns with ciguatera poisoning. Tagging studies provide a unique opportunity to assess the condition of a relatively unexploited resource within the Main Hawaiian Islands (MHI). Kahala species include the greater amberjack, *Seriola dumerili* and the almaco jack, *S. rivoliana*. However, due to the difficulty for volunteer anglers to distinguish between the two species in the field, the two species will be summarized collectively as amberjacks or kahala for this report.

Over 1773 kahala have been tagged from March 1999 to December 2004. Out of these tagged fish, 156 individual fish were recaptured (8.8% recovery rate). The majority of the recaptured individuals were adults providing some limited information on growth and movement.

RECRUITMENT

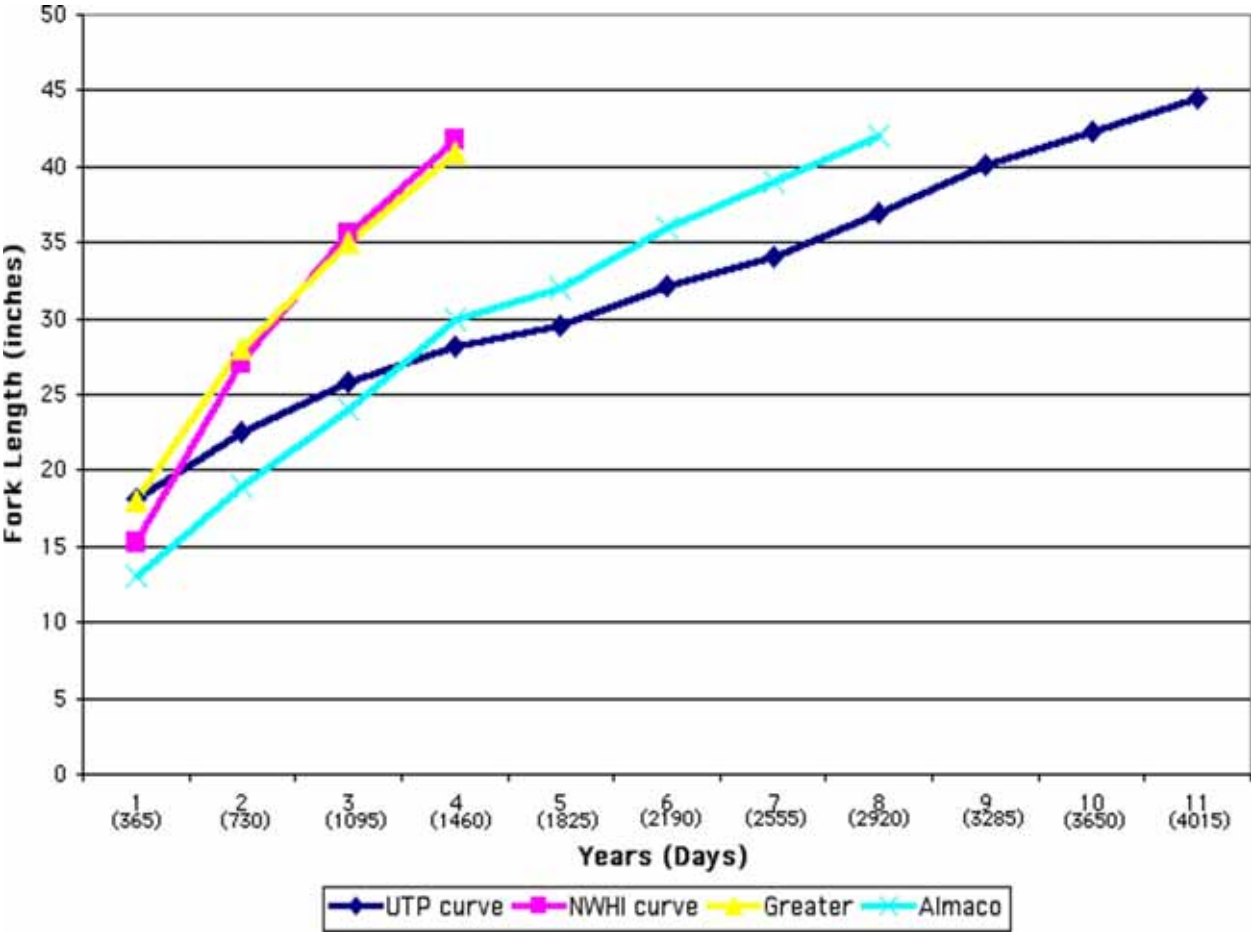
A few juvenile kahala at 6" to 12" FL were caught along the shoreline between March through August. However, an 8.5 inch juvenile was also caught at the ZZ Fish Aggregation Device buoy which is located 9.2 nautical miles from Kawaihae Lt. on the Island of Hawaii. It's unclear where most of the juveniles are located. A few adults will venture inshore when small prey items are abundant, but the majority are found in deeper depths most of the time.

GROWTH

Based on one recovery that was originally tagged as a juvenile, that fish had grown 13 inches over 275 days at liberty. Growing from 9" to 22" FL, it had a growth rate of approximately 1 inch for every 21 days. The remaining fish had been tagged at a fork length of 22 inches and larger. At this length, the fish are considered sexually mature (Kikkawa and Everson 1984), but appear to have a slower growth rate of approximately 1 inch for every 203 days on average.

Figure 20 depicts the growth of kahala within the MHI from the tagging data as it compares with the Von Bertalanffy growth curve calculated from kahala data taken from the NWHI (Humphreys 1986). The Von Bertalanffy growth curves for immature kahala in the NWHI and the MHI are very close. However, as the kahala approaches the size of sexual maturity (21.3 inches FL), the growth rates of adult kahala in the MHI appear slower than the growth rate of those in the NWHI.

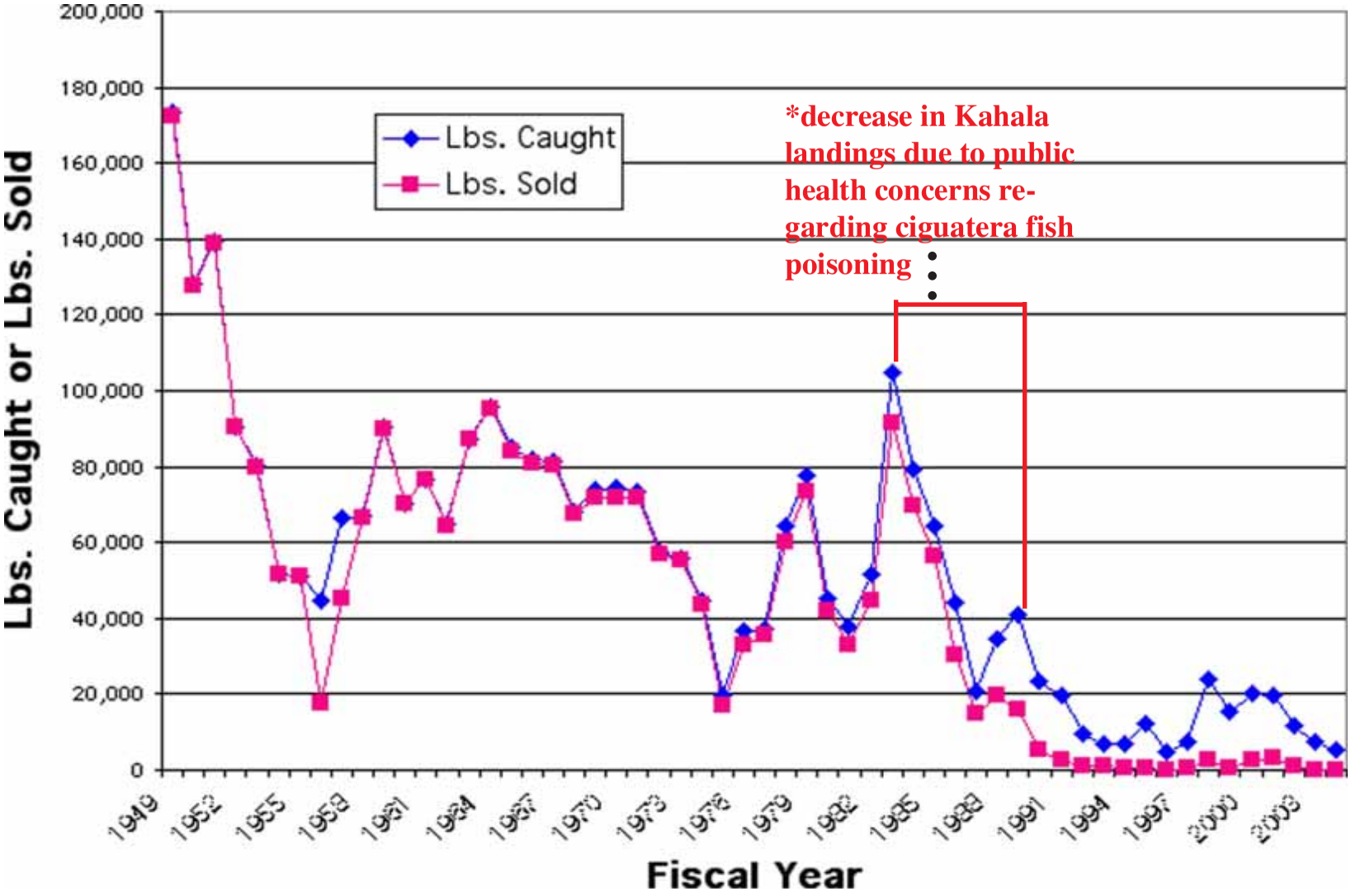
Figure 20. Ulua Tagging Project, NWHI, Greater & Almaco Amberjack Growth Curves



The slower growth of MHI kahala may be influenced by a variety of factors. As an underutilized resource, the kahala in the MHI are no longer commercially fished due to its association with ciguatera fish poisoning. However, some kahala are still being consumed on occasion by recreational and subsistence fishermen who do so at their own risk. This concern over ciguatera fish poisoning has caused a major decrease in the commercial landings reported for kahala since the 1980's (Figure 21). Without previous knowledge on the historical background of the kahala fishery in Hawaii, the commercial landing data could easily be misinterpreted as a decline in abundance. A relatively unexploited top predator resource like the kahala projects a probability that there could be a problem with competition for food and space amongst each other. Slower growth can signify limited food sources for the Kahala, especially for those that are resident populations.

Other things to consider include the difference in diet between the NWHI kahala and the MHI kahala. Octopus and bottom-associated prey are the predominant dietary components in the NWHI whereas *Decapterus* (opelu) and water column-associated prey are predominant in the main islands (Humphreys 1986).

Figure 21 . Commercial Kahala Landing Trends, Fiscal Years 1948 - 2004



MOVEMENT/MIGRATION

Out of 160 kahala recaptures, 39 had traveled 2 miles or more in distance. The majority of these fish were adults (>25" FL) and 33 out of 39 were tagged and recaptured on the Island of Hawaii. Movement patterns show general clockwise or counterclockwise movements around the Big Island (Figure 22). Directional movement for the kahala was determined in the same way as the omilu and white papio where it is based on the majority of fish recaptured during the month indicating travel in a particular direction. The data indicates that the majority of these fish travel in a clockwise direction from March to October. From November to February, they exhibit the opposite counterclockwise movement.

Figure 22. Notable Movement Patterns of Kahala Recaptured Between 2000 to 2004

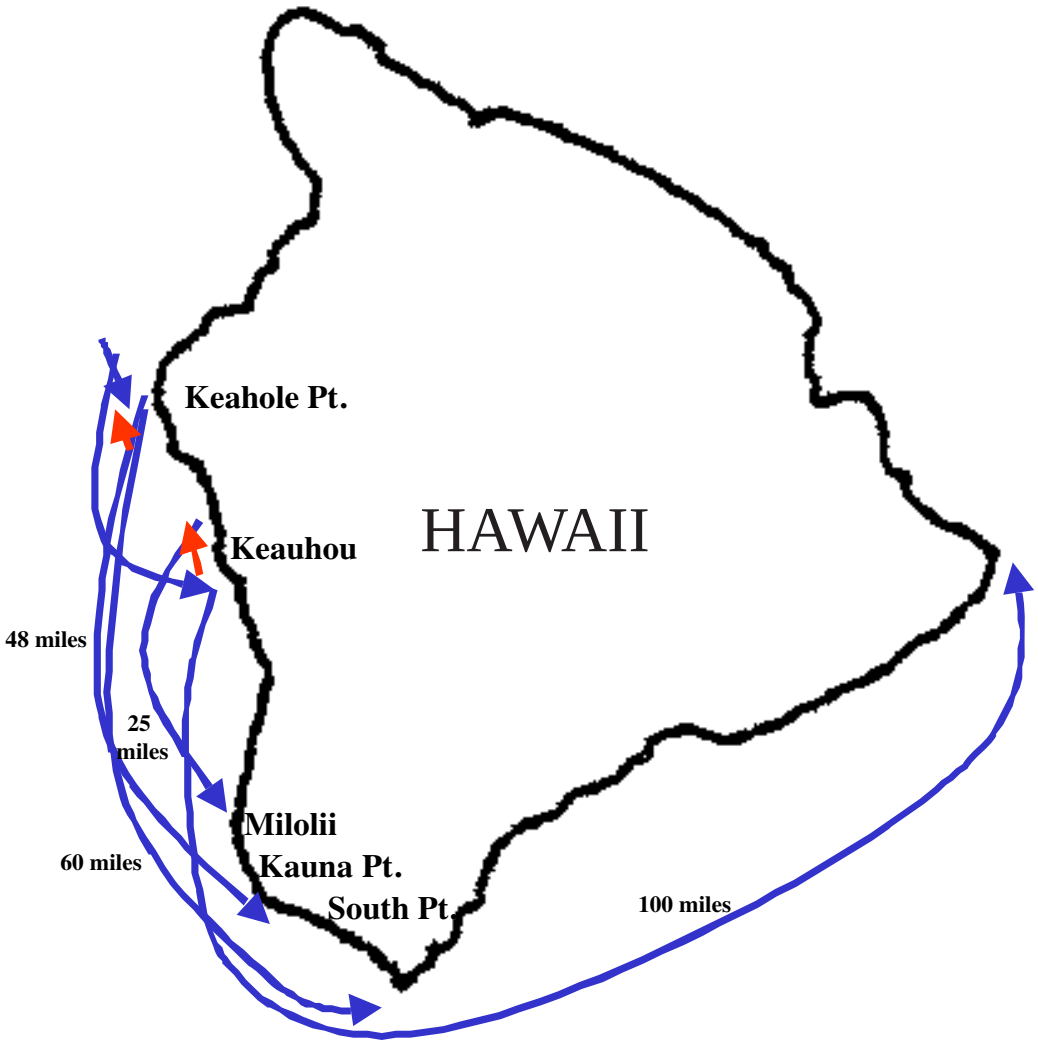
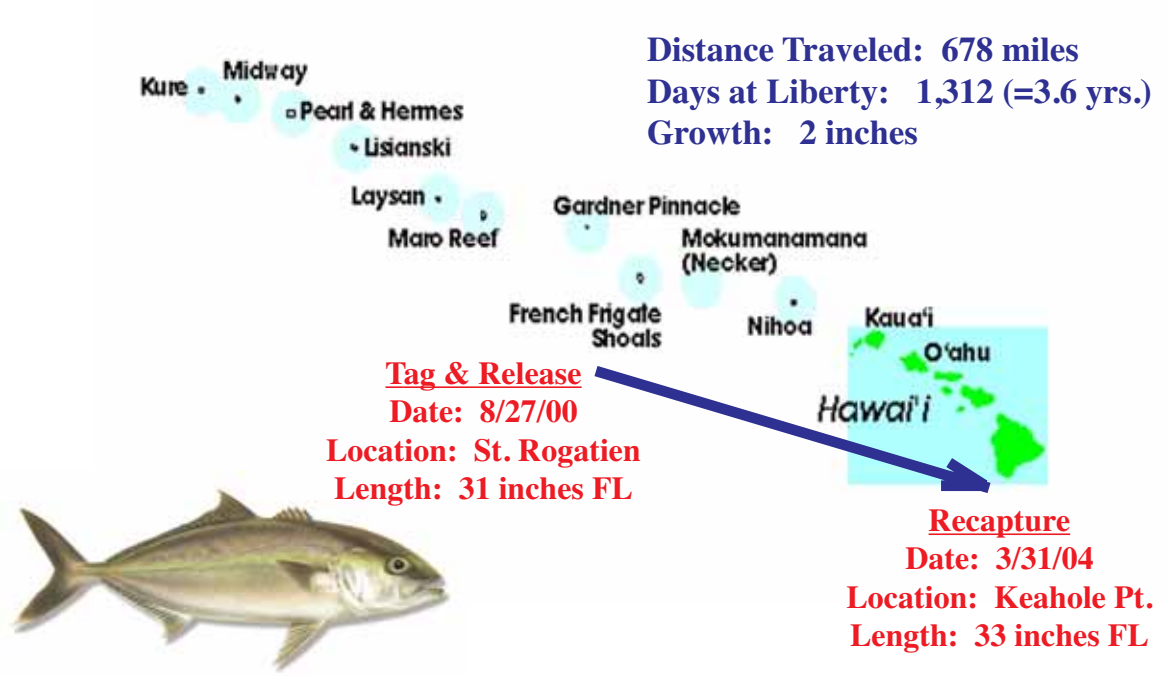


Figure 23. Interisland Movement Pattern of Kahala



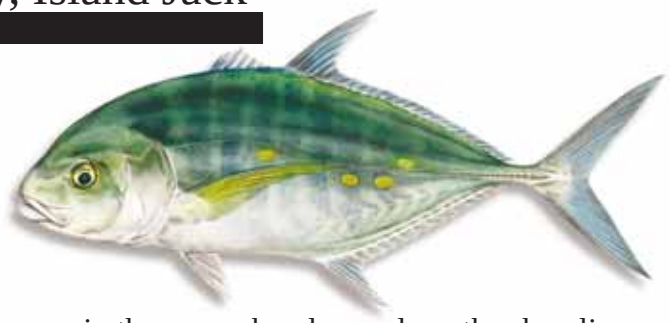
One fish in particular was tagged in the NWHI on 6/27/2000 and recaptured 3.6 years later at the Big Island on 3/31/04 (Figure 23). It had grown 2 inches and traveled a remarkable 678 miles southeast.

DISCUSSION

At this time, there is no need to implement a management regimen to limit the harvest of kahala. There appears to be an ample supply of kahala resources around the MHI, enough to support a viable fishery if ciguatera were not an issue. Testing of commercially landed kahala for ciguatera was done during the late 1970's and early 1980's (Shomura 1981). This testing program enabled vendors to market large numbers of kahala that were safe for human consumption. There were no incidents of reported ciguatera poisoning from kahala that tested negative for ciguatera. Unfortunately, this testing program ended and has not been administered since the 1980's leaving the kahala resources a commercially unexploited stock. If the testing program were to be reinstated, the kahala resources could once again be utilized. An increase in the utilization of the kahala resources may have a positive effect on the other bottomfish fisheries by reducing predation and competition for food and habitat.

Papa, Yellow-Spotted Trevally, Island Jack

Carangoides orthogrammus



The yellow-spotted trevally or papa, does not occur in the same abundance along the shoreline as the white papio or omilu, but they are caught often enough to make their presence known in Hawaiian waters. A total of 332 papa were tagged and released throughout the State. The majority, 226, were caught on the Island of Hawaii.

RECRUITMENT

These fish are seen along the shoreline between June to December with peak numbers occurring in September and October. The smallest papa tagged to date is about 7" FL. Papa measuring 7" to 8" FL begin appearing along the shoreline around June (See Figure 24a,b & c). The tagging data indicates that the papa enter the fishery at 9" to 10" FL. The numbers start to decline around November to December as they reach the 11" to 12" FL size range. Since these fish are known to begin reaching sexual maturity at 12" FL, this may indicate that these species are moving toward deeper waters at this size.

GROWTH

A total of 12 papa recaptured between August to December provides a preliminary growth rate of 0.5" per month during this time period. Papa are rarely seen along the shoreline during the rest of the year (January to May) making it difficult to assess any seasonal growth for this species.

MOVEMENT/MIGRATION

Almost all of the papa caught at the shoreline are considered juveniles. Farthest distance traveled by a tagged papa is 2.5 miles. As previously stated, the number of papa along the shoreline begin to decline once the fish reach 11" to 12" FL which is the beginning of the size range that this species is found to be sexually mature (Froese and Pauly 2005). It is suspected that because this is the size that they begin to reach sexual maturity, they begin moving out to deeper depths as evidenced by larger fish ranging in size from 23" to 26.5" FL being caught and tagged in depths of 60 to 72 fathoms by volunteer anglers. More tag and recovery data is needed to confirm this.

DISCUSSION

The papa does not normally occur in numbers as abundantly as the omilu or white papio. However, it does account for 2% of the nearshore ulua and papio species that are captured and tagged. At the present time, there is not enough information to conduct a stock assessment analysis for this spe-

cies. Continued tag and recapture efforts for this species are necessary in order to obtain the information needed to conduct a stock assessment of the papa resources.

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Figure 24a. 2002 Papa Recruitment

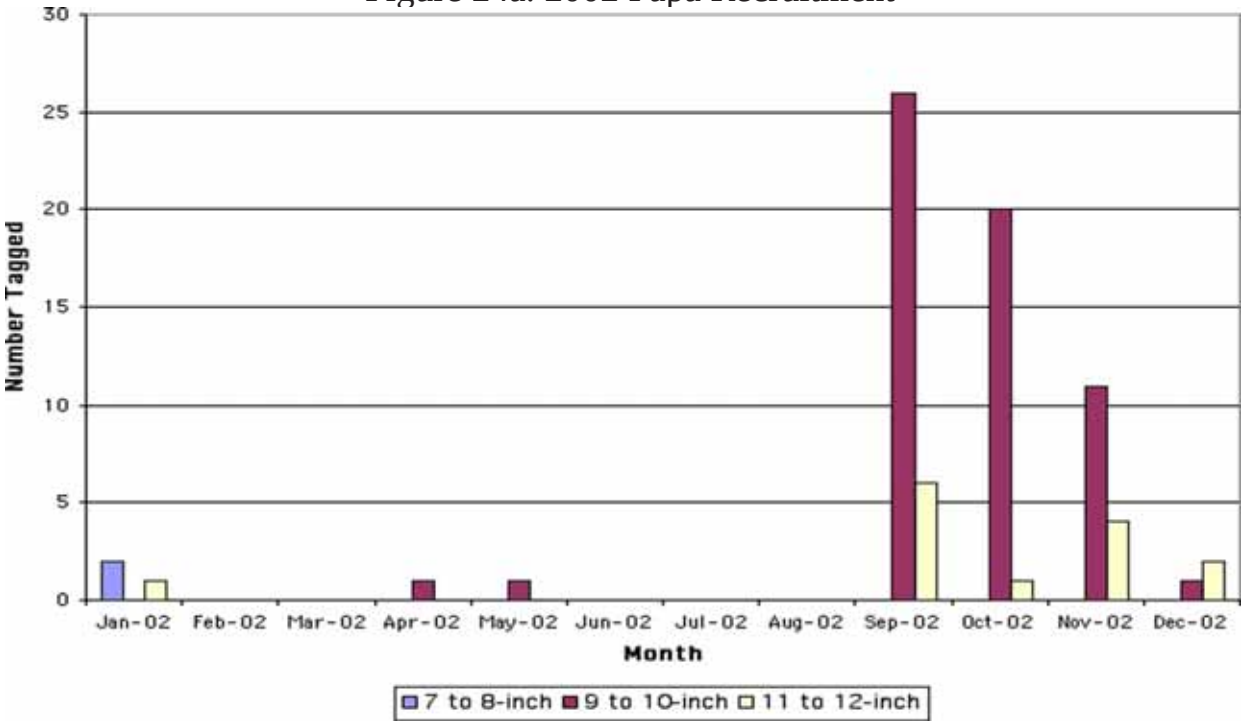


Figure 24b. 2003 Papa Recruitment

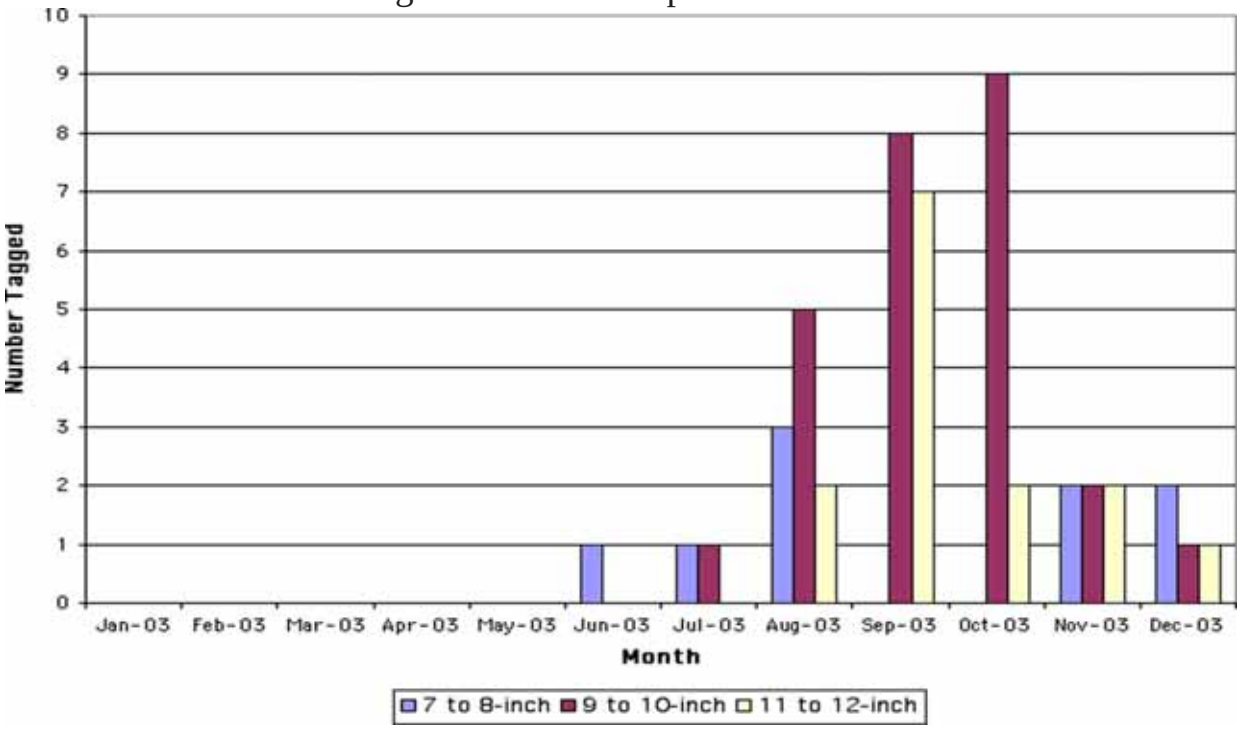
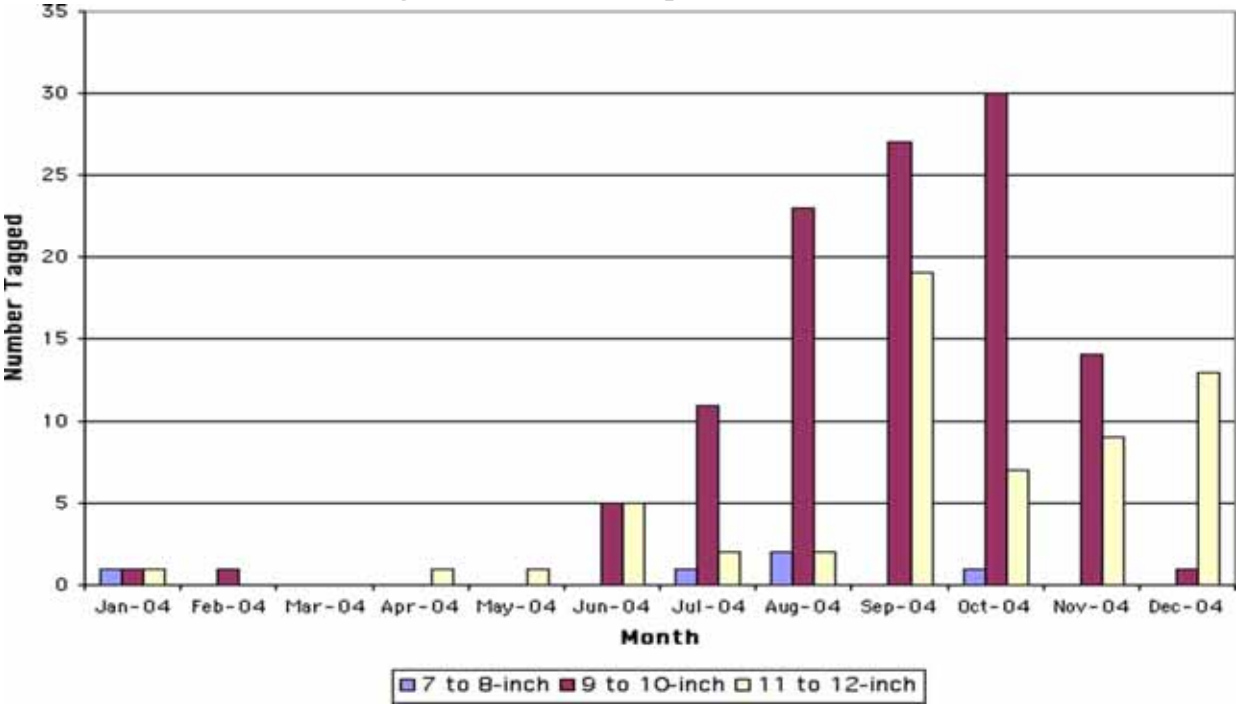


Figure 24c. 2004 Papa Recruitment



Barred Jack

Carangoides ferdau

The barred jack is not an abundant species in Hawaii, but they are occasionally caught by local fishermen. A total of 95 barred jacks were tagged and released throughout the State with the majority being caught on Oahu. Twenty-five were recaptured (26.3% recapture rate) with an average 49 days of freedom. The majority of fish tagged and released were juveniles.

RECRUITMENT

Juvenile barred jacks between 6" to 8" FL are seen on the shoreline between August to December (See Figure 25a,b & c). The largest individual seen in shallow waters is 11.5" FL. Larger individuals 17" FL and over have been caught and tagged in deeper waters near the coasts of Maui and the Big Island. Barred jacks are known to begin reaching sexual maturity at 14.5" FL (Froese and Pauly 2005). This leads us to suspect that as these fish approach sexual maturity, they move to deeper waters as adults. Further tag and recovery efforts are needed to confirm this.

GROWTH

Limited information is available on growth due to the small amount of barred jacks tagged and recaptured. Based on recovery information, juvenile barred jacks exhibit an average growth of 0.4 inches per month between August to December. More tag and recovery data is needed to verify growth rates. Barred jacks rarely occur along the shoreline during the rest of the year making it difficult to obtain any data on these species during the first part of the year.

MOVEMENT/MIGRATION

It appears from the recovery data that barred jacks 11" FL and larger will travel distances of over 2 miles whereas those under 11 inches remain in the same area. As mentioned previously, there is speculation that this species moves into deeper waters as they become mature. More data is needed to confirm this.

DISCUSSION

Barred jacks account for less than 1% of the nearshore ulua and papio species that are captured and tagged. At the present time, there is not enough information to conduct a stock assessment analysis for this species. Continued tag and recapture efforts for this species are necessary in order to obtain the information needed to conduct a stock assessment for the barred jack resources.

Figure 25a. 2002 Barred Jack Recruitment

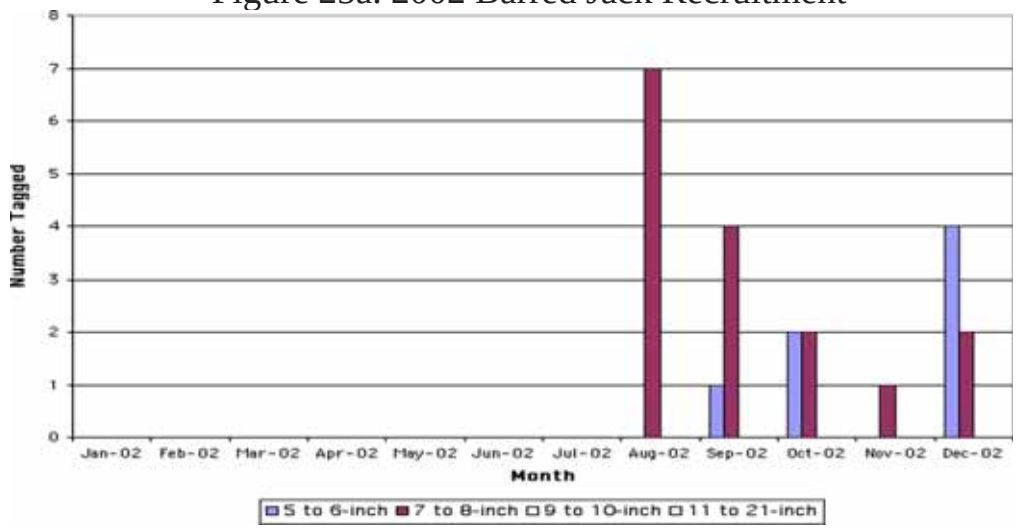


Figure 25b. 2003 Barred Jack Recruitment

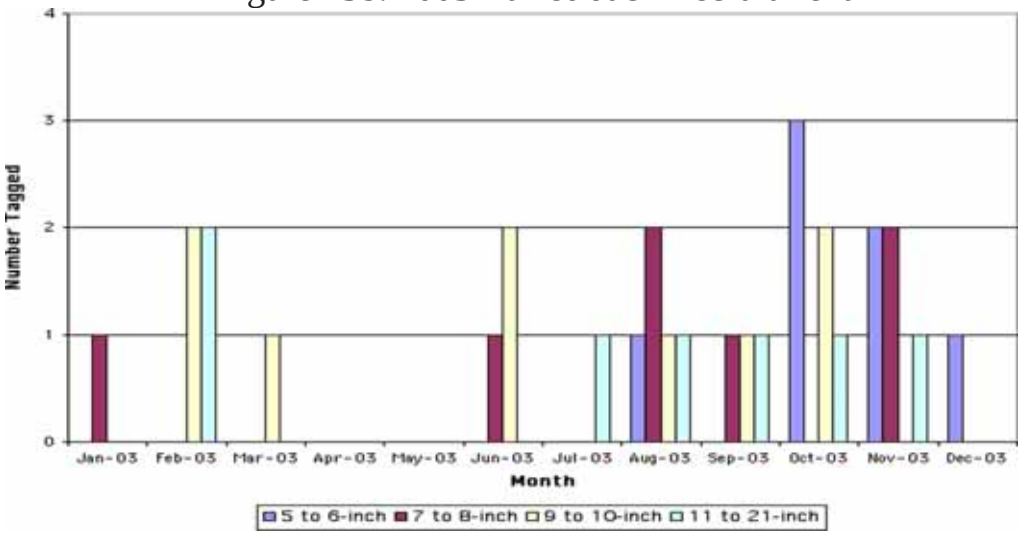
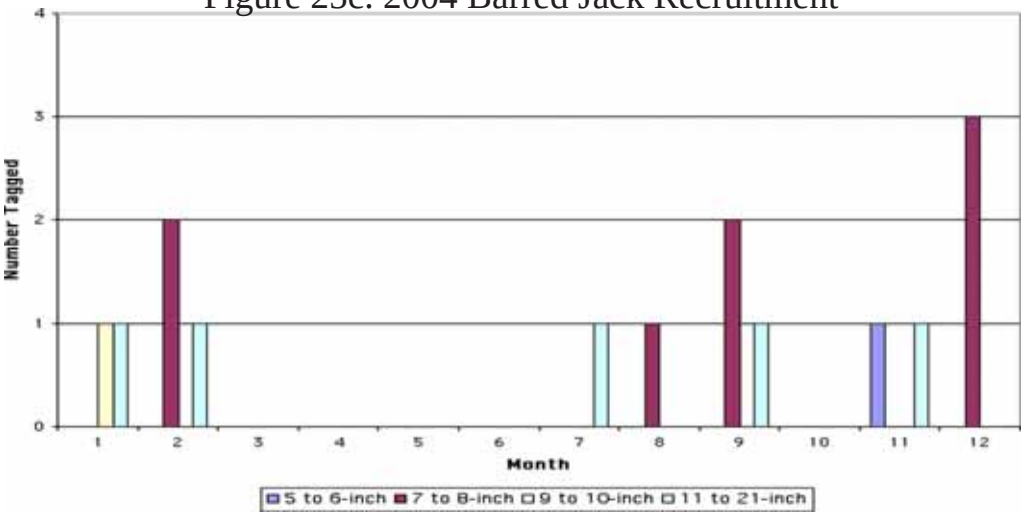
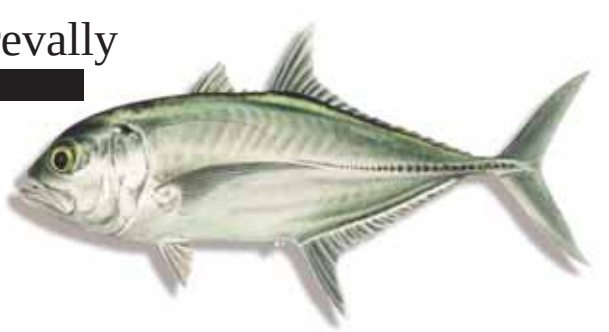


Figure 25c. 2004 Barred Jack Recruitment



Menpachi Ulua, Sasa, Bigeye Trevally

Caranx sexfasciatus



The bigeye trevally is another species that is not normally abundant, but it is common enough that most fishermen will occasionally catch one. A total of 348 bigeye trevally were tagged and released throughout the State. Twenty-one individuals were recaptured with an average 96 days of freedom. The majority of fish caught were juveniles.

RECRUITMENT

Bigeye trevally between 4" to 6" FL begin to appear along the shoreline during October (Figures 27a&b) continuing into January through March of the following year. In August 2004 juveniles measuring 2.4" FL were found occurring in mixed species schools consisting of white papio, juvenile omilu, juvenile bigeye trevally and sardines in the Waikiki area on Oahu (Figure 26a). Samples collected and grown in captivity confirmed that these were juvenile bigeye trevally (Figure 26b).

GROWTH

In general, growth was calculated to average 0.34 inches per month. There is some indication that there may be some seasonal growth, but there were not enough recoveries to determine this. More recoveries are needed to verify growth rates.

MOVEMENT/MIGRATION

The majority of recaptured bigeye trevally measuring between 8.5" to 9.5" FL exhibited minimal to no movement. However, two individuals at this size had traveled an average distance of 2.6 miles. Other recaptured individuals measuring between 10" to 13.5" FL were found to venture further up to 3.5 miles. Fish recaptured at 14" to 14.5" FL were found to travel an average of 9.6 miles. Length of maturity for this species ranges from 13" to 23" FL (Froese and Pauly 2005). The fork

Figure 26a. Juvenile Bigeye Trevally, 2.4 inches FL, 9/2/04. Photo by Mike Yamamoto

Figure 26b. Juvenile Bigeye Trevally, 7.5 inches FL, 4/22/05. Photo by Thomas Iwai Jr.

length measurement on the majority of recaptured individuals that have traveled over 2 miles fall within the size range of sexually mature fish. Various fishermen reported they caught larger ones in deeper water. Bigeye trevally 18" FL and larger have been caught amongst schools of akule and halalu, *Selar crumenopthalmus,* that are further offshore. In addition, large bigeye trevally have also been caught within offshore *Thunnus albacares* aggregations known locally as ahi koas. Perhaps as these species reach maturity, they venture out into deeper depths.

DISCUSSION

Bigeye trevally account for less than 2% of the nearshore ulua and papio species that are captured and tagged. At the present time, there is not enough information to conduct a stock assessment analysis for this species. Continued tag and recapture efforts for this species are necessary in order to obtain the information needed to conduct a stock assessment for the bigeye trevally resources.

Figure 27a. 2003 Bigeye Trevally Recruitment

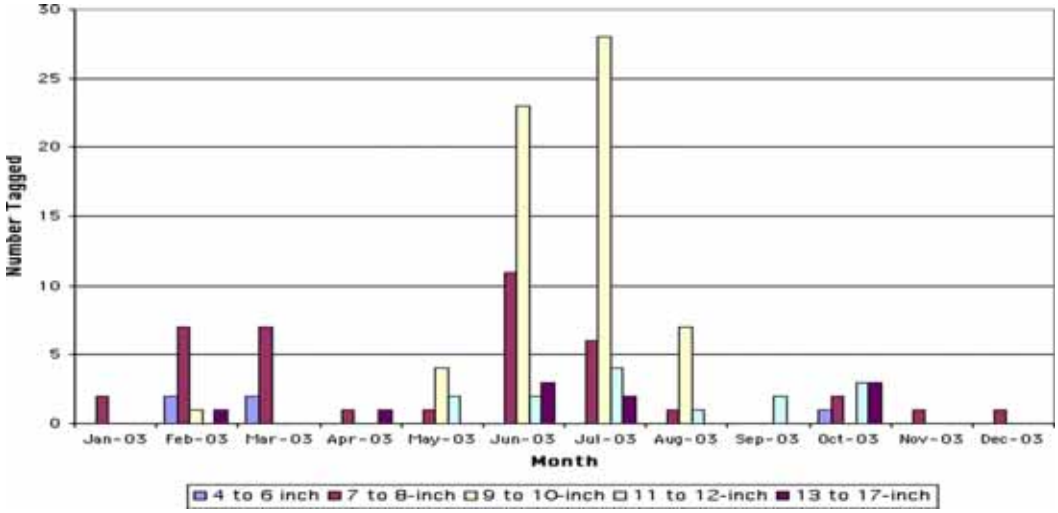
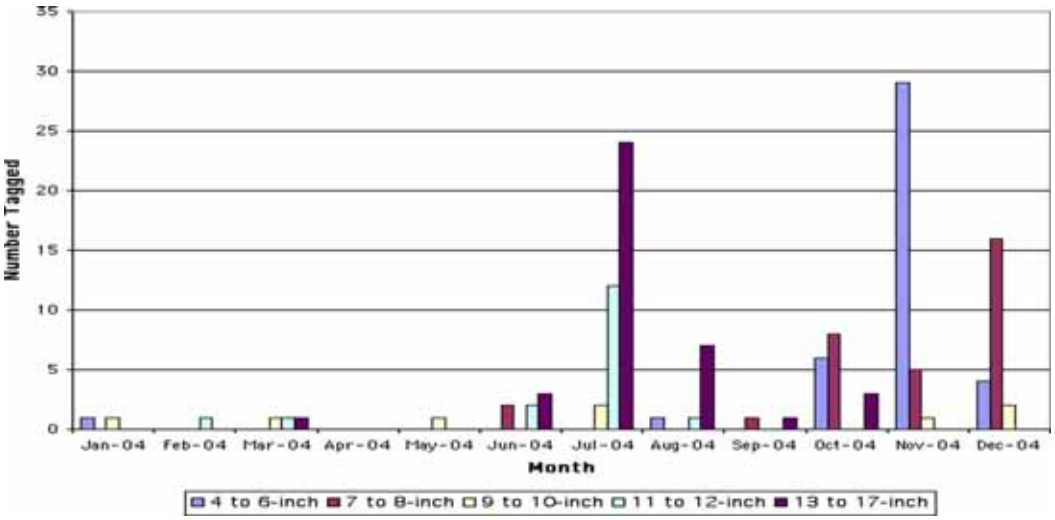


Figure 27b. 2004 Bigeye Trevally Recruitment



Ulua pa‘opa‘o, Yellow Ulua, Golden Trevally

Gnathanodon speciosus

The golden trevally is also not very abundant, but is valued as a food and game fish among fishermen. A total of 55 golden trevally were tagged and released throughout the State. Fifteen individuals were recaptured with an average 40 days of freedom. Thirty-three percent of the fish caught were in the adult size range measuring 16.5” to 29” FL The remaining 67% were juveniles ranging in size from 5” to 15.25” FL

RECRUITMENT

Preliminary data shows that small individuals between 5” to 7” FL appear along the shoreline between August and October (Figure 28). Adult fish (>15” FL) can be found along the shore throughout most of the year.

GROWTH

Calculated growth rate is approximately 0.30 inches per month. More tag and recovery data is needed to determine if there are any seasonal growth rates.

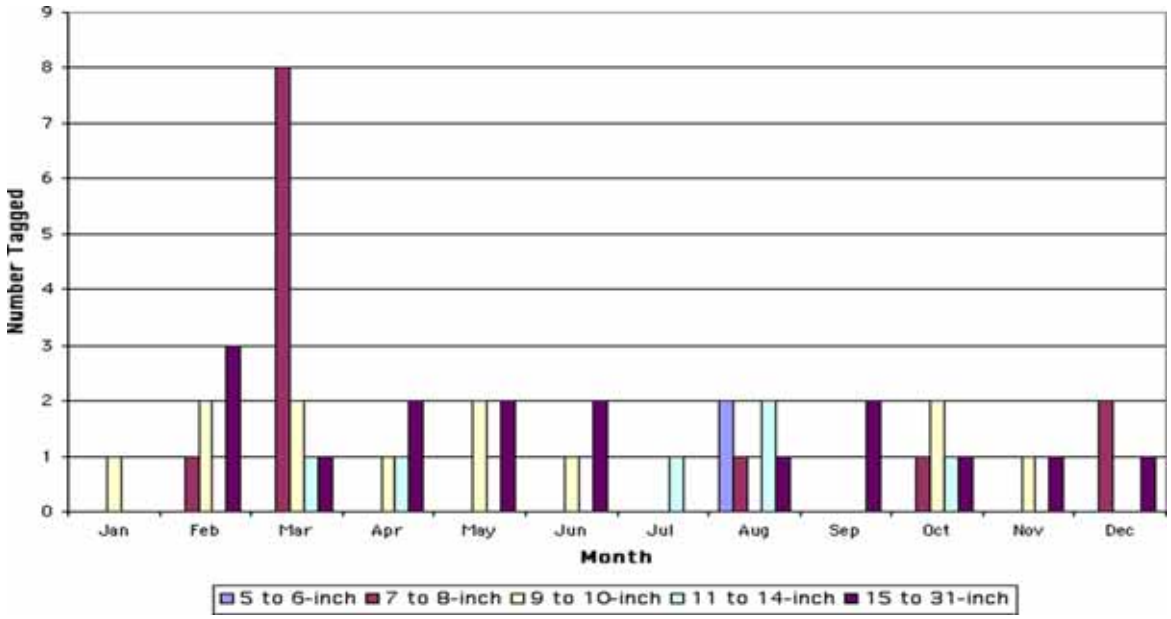
MOVEMENT/MIGRATION

Golden trevally show very little movement indicating that they remain within the same area since recruitment. Further tag and recovery efforts are needed to determine if they remain in the same area throughout their adult life or if there is movement at some point.

DISCUSSION

Golden trevally account for less than 0.5% of the nearshore ulua and papio species that are captured and tagged. At the present time, there is not enough information to conduct a stock assessment analysis for this species. Continued tag and recapture efforts for this species are necessary in order to obtain the information needed to conduct a stock assessment for the golden trevally resources.

Figure 28. Golden Trevally Recruitment Between 2002 to 2004



Dobe Papio, Whitemouth Jack

Uraspis helvola

The dobe papio is normally considered a deeper water species occurring at depths of about 100 to 200 feet often near ledges and dropoff areas (Froese and Pauly, 2005). However during the last four years, shoreline fishermen have reported catching these fish from shore at Hickam Air Force Base on Oahu, Waianae, Oahu and Nawiliwili, Kauai during January to June. At times, fishermen have reported seeing large schools that come inshore for a very brief time. A total of 18 fish ranging from 7.5" to 14" FL were tagged with no reported recoveries at this time.

RECRUITMENT

Sixteen out of the 18 fish tagged measured between 9.25" to 14" FL. These fish fall within the size range of fish that are considered sexually mature. Dobe papio begin reaching sexual maturity between 9" to 16" FL (Froese and Pauly, 2005). The remaining 2 fish are considered juveniles ranging in size from 7.5" to 8.25" FL. Other than brief appearances along the shorelines of Oahu and Kauai during the months of January to June, no other information is available on recruitment of this species. More tag and recovery effort is needed for further information.

GROWTH

No information is available from the tagging data. More tag and recovery effort is needed to determine growth rates for this species.

MOVEMENT/MIGRATION

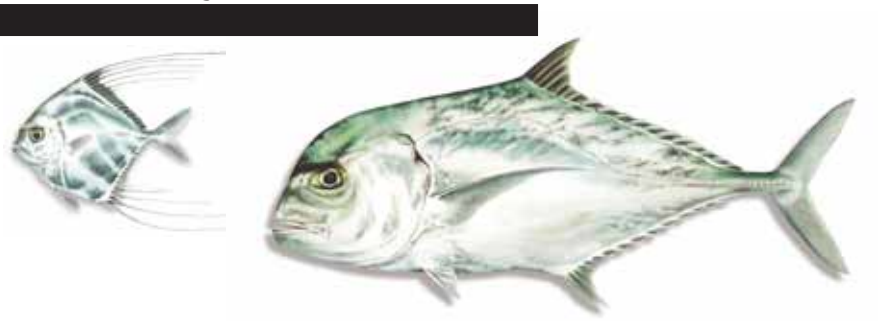
After a brief appearance by this species along the shoreline, the entire school disappears. The current assumption is that the school is perhaps migrating back to deeper depths where they are normally found. More tag and recovery effort is needed to determine this.

DISCUSSION

Dobe papio account for less than 0.1% of the nearshore ulua and papio species that are captured and tagged. At the present time, there is not enough information to conduct a stock assessment analysis for this species. Continued tag and recapture efforts for this species are necessary in order to obtain the information needed to conduct a stock assessment for the dobe papio resources.

Kagami Ulua, Mirror Trevally, Threadfin Jack

Alectis ciliaris



Mirror trevallys are not extremely common along the shoreline, but fishermen tend to catch them occasionally. A total of 31 mirror trevallys were tagged and released with one recapture reported. The majority of fish caught were under 20" FL and considered juveniles.

RECRUITMENT

Tagging data suggests recruits for this species may be occurring during July through November. Juveniles measuring 4" to 7" FL can be found along the shoreline at this time.

GROWTH

No information is available from the tagging data on growth. Further tag and recapture information is needed to determine any growth rates.

MOVEMENT/MIGRATION

No movement information available due to limited amount of tagging data.

DISCUSSION

Mirror trevallys account for less than 0.2% of the nearshore ulua and papio species that are captured and tagged. At the present time, there is not enough information to conduct a stock assessment analysis for this species. Continued tag and recapture efforts for this species are necessary in order to obtain the information needed to conduct a stock assessment for the mirror trevally resources.

Butaguchi, Buta Ulua, Thicklipped Jack

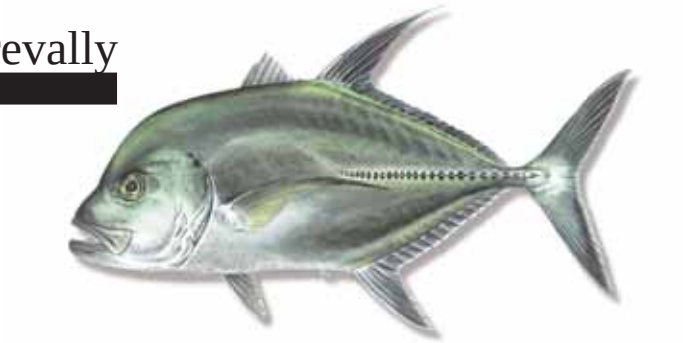
Pseudocaranx dentex

Butaguchi are more commonly caught in the Northwestern Hawaiian Islands than they are in the Main Hawaiian Islands. A total of 94 butaguchi ranging in size from 20" to 36.5" FL were all tagged and released in the Northwestern Hawaiian Islands. All were within the size range of mature fish. None have been recaptured as of yet.

There is no current management regimen for the butaguchi. More information is needed on the butaguchi population to determine if this fishery is being fished sustainably.

Black Ulua, Gunkan, Black Trevally

Caranx lugubris



Black Trevallys are extremely rare throughout Hawaii. A total of 4 adult fish measuring between 28" to 34.5" FL were tagged and released. Three of them were tagged in the NWHI and one was tagged at South Point on the island of Hawaii. None have been recaptured as of yet.

Continued tag and recovery efforts are needed to obtain more information on the black trevally population in Hawaii.

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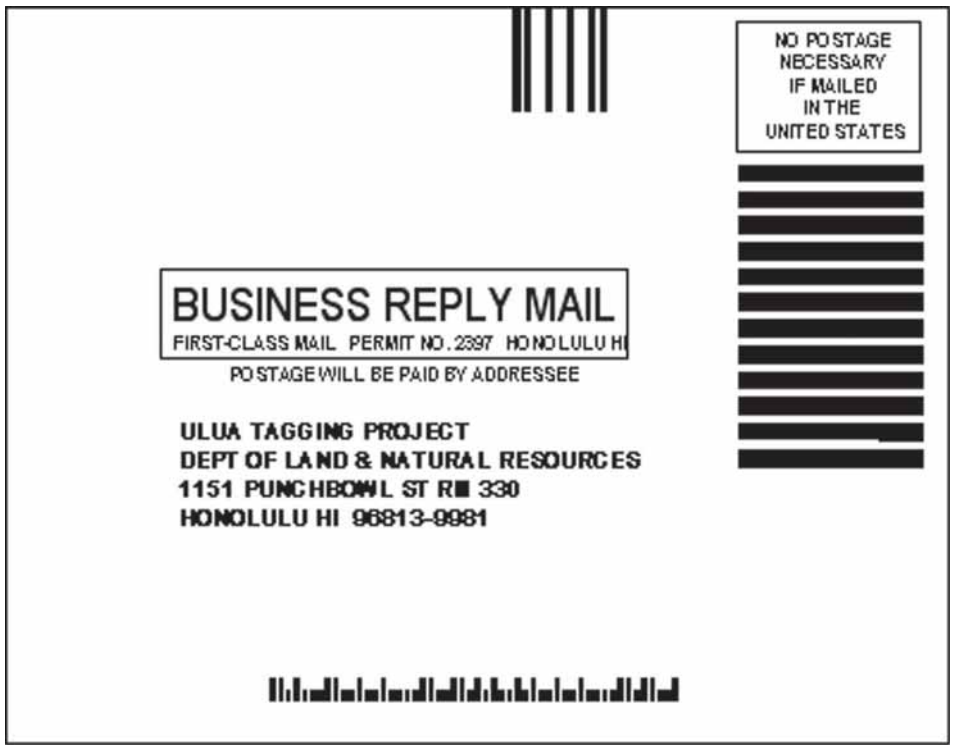
APPENDICES

APPENDIX A

DATA RETURN CARD



FRONT

Please record information and return by mail when all tags have been used
NO POST AGE NECESSAR Y

ULUA TAGGING DATA

DATE	TAG NO.	SPECIES	FORK LENGTH (inches)	TIME CAUGHT	LOCATION CAUGHT/ RELEASED

◯ Please check here to request more tags Quantity _____

BACK

APPENDIX B

RECOVERY RESPONSE LETTER

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR - LAND

DEAN NAKANO
ACTING DEPUTY DIRECTOR - WATER

BOATING AND OCEAN RECREATION
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

November 19, 2002

Dear Grant Abo

Thank you for your participation in the Aquatic Resources' "Ulua Tagging Project". Fishermen's support and concern is essential to the success of this project. The information gathered through this project will help improve and strengthen resources for future generations to enjoy.

All fishermen who participate in this program whether tagging or in recovery of fish will be given information pertaining to that particular fish. Periodic recaps of the project will be published in our "Current Line" newsletter available at various sporting goods stores or published in the Hawaii Fishing News. In the near future we plan to establish a web site in conjunction with the DLNR web page.

Tagging information for Tag No. **P1079** Species: **omilu**

Tagged By	Date Tagged	Fork Length Tagged (inches)	Location Tagged	Caught By	Date Caught	Fork Length Caught (inches)	Location Caught	Days Free	Distance Traveled (miles)	Growth (inches)
Hooheno Furushima	2/27/2001	7	Point Panic	Hariet Kahihikolo	7/12/2001	10	Point Panic	135	0	3.00
Hariet Kahihikolo	7/12/2001	10	Point Panic	Hariet Kahihikolo	8/17/2001	10	Point Panic	36	0	0.00
Hariet Kahihikolo	8/17/2001	10	Point Panic	Grant Abo	9/9/2002	17	Sand Island Park, harbor entrance	388	2.5	7.00

***Award Item** L T-shirt **Total Days & Growth:** 559 days 10 inches

We would like to award to you with the enclosed item as a token of our appreciation for your participation. Again thank you for your time and effort on this project. If you should have any questions or would like more information, please feel free to call Annette Tagawa or Clay Tam at (808) 587-0593 with the Division of Aquatic Resources' "Ulua Tagging Project". Have a great fishing season!

Sincerely,

Annette Tagawa

Annette Tagawa
Ulua Tagging Project Coordinator

APPENDIX C

TAGGER RESPONSE LETTER

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

November 19, 2002

Dear Hooheno Furushima,

Thank you for your participation in the Aquatic Resources' "Ulua Tagging Project". Fishermen's support and concern is essential to the success of this project. The information gathered through this project will help improve and strengthen resources for future generations to enjoy.

All fishermen who participate in this program whether tagging or in recovery of fish will be given information pertaining to that particular fish. Periodic recaps of the project will be published in our "Current Line" newsletter available at various sporting goods stores or published in the Hawaii Fishing News. In the near future we plan to establish a web site in conjunction with the DLNR web page.

Tagging information for Tag No. **P1079** Species: **omilu** release

Tagged By	Date Tagged	Fork Length Tagged (inches)	Location Tagged	Caught By	Date Caught	Fork Length Caught (inches)	Location Caught	Days Free	Distance Traveled (miles)	Growth (inches)
Hooheno Furushima	2/27/2001	7	Point Panic	Harriet Kahihikolo	7/12/2001	10	Point Panic	135	0	3.00
Harriet Kahihikolo	7/12/2001	10	Point Panic	Harriet Kahihikolo	8/17/2001	10	Point Panic	36	0	0.00
Harriet Kahihikolo	8/17/2001	10	Point Panic	Grant Abo	9/9/2002	17	Sand Island Park, harbor entrance	388	2.5	7.00

Total Days & Growth: 559 days 10 inches

Again thank you for your time and effort on this project. If you should have any questions or would like more information, please feel free to call Annette Tagawa or Clay Tam at (808) 587-0593 with the Division of Aquatic Resources' "Ulua Tagging Project". Have a great fishing season!

Sincerely,

Annette Tagawa

Annette Tagawa
Ulua Tagging Project Coordinator

APPENDIX D

Aweoweo & Oama Mystery,
Ulua Tagging Project Newsletter,
Volume 2, Number 1, May 2005
DLNR -Division of Aquaic Resources

Huge aweoweo run in 2003? Lack of oama in 2004? – what's going on out there on the shoreline? Is there a link between the ulua and papio tagging data and these occurences? Take a look below at what the Ulua Tagging Project data on papio growth and movement may be telling us.

2003 Year of the Aweoweo

As all of you may recall, the aweoweo (Priacanthus meeki) run of 2003 was one of the largest recruitments of this fish anyone has seen in Hawaii since the 1960's.

On the shoreline during the early part of July 2003, there were reports of aweoweo running on Kauai's west side and within three weeks, had circled the entire island of Kauai. Within the first week of the Kauai aweoweo run, Oahu also started to experience the aweoweo run which continued throughout the month of August. The run spread completely around the island of Oahu. Toward September 2003, the islands of Maui and Molokai experienced a small limited run, which made a very brief appearance and then disappeared entirely. The Big Island had no report of an aweoweo run.

So how does our Ulua and papio data tie in to this unusual aweoweo phenomenon? Let's begin with a review on what the papio movement data has been showing us.

General movement patterns of omilu (Caranx melampygus) and white papio (Caranx ignobilis) on Oahu were based on monthly recovery data from volunteer anglers participating in the Ulua Tagging Project. It appears that recapture data from years 2000 to mid-2003 has shown that papio were generally moving in a clockwise direction around the island between the months of September to March and then switched to a counterclockwise pattern from March to September (see Fig. 2). Much of this directional movement is possibly related to current patterns occurring during certain times of the year around Oahu. It's commonly known among fishermen that predator fish such as the ulua and papio, will tend to orient themselves facing the oncoming currents to maximize feeding efforts by allowing the currents to bring the food toward them. As such, the fish tend to move in the opposite direction of the current at any given time.

Fig. 2. General Movement Patterns of Omilu and White Papio on the Island of Oahu

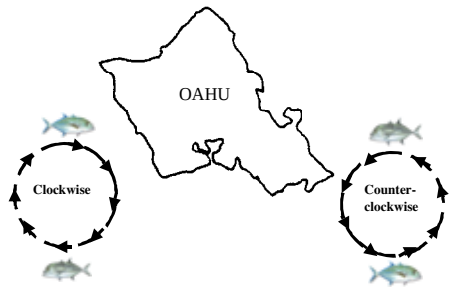


Fig. 3. General Movement Patterns of Omilu and White Papio on the Island of Oahu July 2003

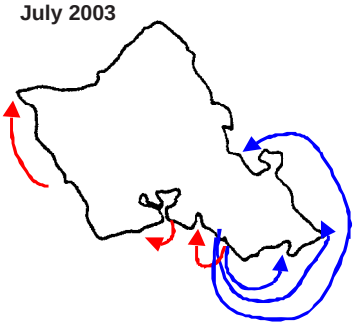


Fig. 4. General Movement Patterns of Omilu and White Papio on the Island of Oahu August 2003

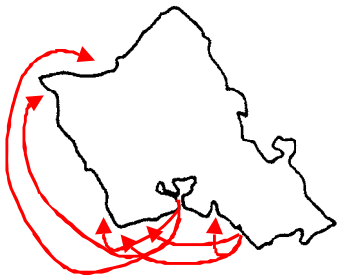
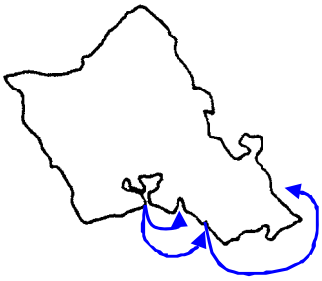


Fig. 5. General Movement Patterns of Omilu and White Papio on the Island of Oahu September 2003



Based on previous papio movement patterns for 2001 and 2002, we had expected the majority of fish to be moving in a counterclockwise direction around the island in July 2003. However, as recapture data for July 2003 came in, movement patterns were very unusual, showing that the papio were moving equally in both the clockwise and counterclockwise directions (see Fig. 3). The direction was contrary to what we saw in the previous years! Then the August 2003 recapture data revealed that over **90%** of the papio were moving in a clockwise direction, which was the complete opposite of the previous 2 years (see Fig. 4). By mid September of 2003 the data indicated a return by the majority of fish to the expected counterclockwise movement pattern (see Fig.5).

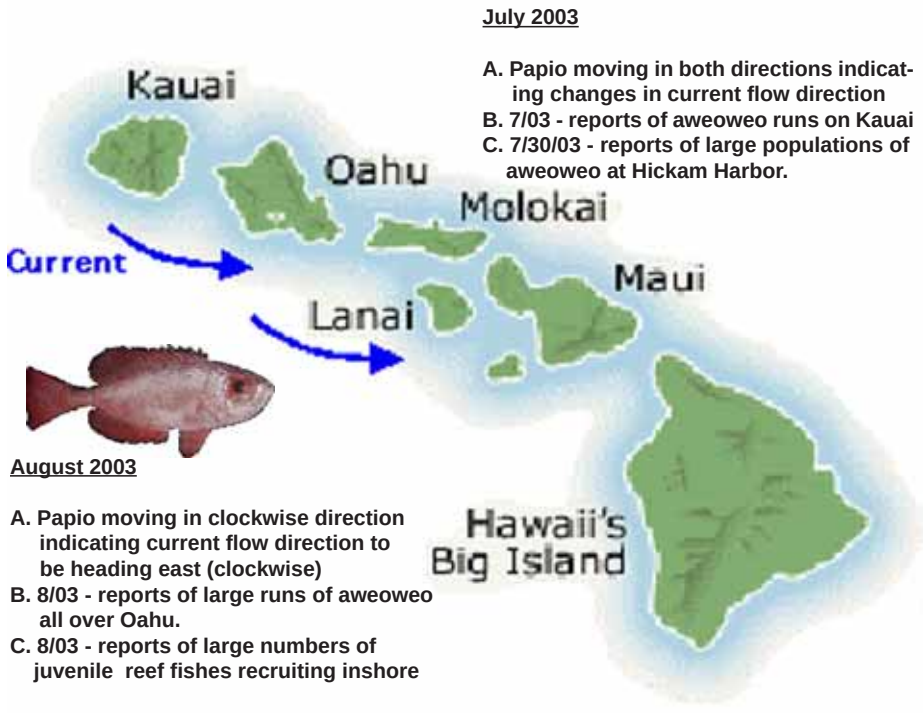
If the papio movement patterns during the summer of 2003 are related to ocean current patterns, we can then begin to match these with other observations that were reported to us by Ulua Tagging Project volunteer anglers (refer to Fig. 6).

For example, one event that indicated a strong easterly traveling current was the Annual Waikiki Rough Water Swim that was held on September 1, 2003. This event starts at San Souci Beach in Waikiki and ends near the Hilton Hawaiian Village located 2.4 miles west. Many of the swimmers in that event encountered a very strong easterly moving current. Because of this, approximately half the field of swimmers could not complete the swim and many had to be rescued. But a week later some of the same competitors who failed earlier to complete the swim, tried to complete it this time on their own. By this time the current had switched back to a westward direction and those swimmers were able to complete the swim.

By putting all the pieces of the puzzle together (data + observations), all of the information gathered tells us that the ocean current patterns changed between June 2003 and July 2003 coinciding with the beginning of the aweoweo run on Kauai (see Fig. 6). As the currents continue to move in an easterly direction throughout August 2003, this brought the aweoweo further down the chain to Oahu and parts of Molokai and Maui. When the current patterns began switiching back to a westerly direction in September 2003, the aweoweo run began to slow down. As you can see, the papio movement patterns provided some evidence that ocean currents may have played a role in bringing the aweoweo run to our islands.

Fig. 7. 2004 Angler with Aweoweo Catches (Oahu)

Fig. 6. 2003 Aweoweo (Priacanthus meeki) Recruitment



July 2003

A. Papio moving in both directions indicating changes in current flow direction
B. 7/03 - reports of aweoweo runs on Kauai
C. 7/30/03 - reports of large populations of aweoweo at Hickam Harbor.

August 2003

A. Papio moving in clockwise direction indicating current flow direction to be heading east (clockwise)
B. 8/03 - reports of large runs of aweoweo all over Oahu.
C. 8/03 - reports of large numbers of juvenile reef fishes recruiting inshore

September 2003

A. Papio moving in counterclockwise direction indicating current flow direction to be heading west (clockwise)
B. 9/1/03 -Waikiki Rough Water Swim, current going east (counterclock)
C. 9/6/03 - based on news report of rough water swim participants who were doing the swim on their own today, current was going west (clockwise)
D. 9/15//03 - reports of aweoweo runs slowing down on Oahu.
E. 9/5-19/03 - reports of limited aweoweo runs on Maui & Molokai

In 2004, a follow up of the 2003 aweoweo run revealed that despite the heavy fishing effort that occurred for these fish as juveniles in 2003, there were still more than enough left on our reefs to develop into the larger adult aweoweo that were being caught along Kauai and Oahu shorelines in 2004 (see Fig. 7).

It would be very interesting to continue monitoring papio movement patterns through the Ulua Tagging Project to see what else the data can tell us when other fish trends or phenomena begin occurring in our islands.

2004 – Where did all the Oama go?

In 2004, with the abundance of mature aweoweo from 2003, along with the lack of oama last year, many fishermen had come to the conclusion that all the oama were eaten by the aweoweo. Have any of you caught aweoweo and found oama in their stomachs? There was a report by one fisherman who was using oama as bait for papio and caught an aweoweo instead, but there has been no other report. So did the aweoweo eat all the oama in 2004? It's possible but highly unlikely since the aweoweo run never made it to the Big Island and the Big Island had reports of no oama also. So what happened?

Periodically we've all seen years where the oama runs have been rather lean or practically nonexistent. 2004 just happened to be one of those years. Our annual summer run of juvenile goatfish or oama, Mulloidichthys flavolineatus, has been absent from shoreline waters around the Main Hawaiian Islands from the Big Island to Kauai. The normally abundant annual recruits of baby goatfish (oama) and mackerel scad or halalu, Selar crumenopthalmus, showed up this year in very small

numbers and in some areas not at all. Thanks to all of you participating as volunteer anglers in the Ulua Tagging Project, last year's growth observations throughout the year, has given us a hint on what may have happened to our oama run last year.

Based on Aku boat fishermen's observations in 2004, they had reported seeing aku feeding on "kuchi hige" referring to the juvenile goatfish in April. The aku and other pelagic fish are known to start feeding on the "kuchi hige" from April through June. Usually this happens prior to the oama runs nearshore in June/July when schools of oama begin recruiting inshore. Most of our goatfish or weke species spend the early part of their life cycle in the open ocean area where they develop until they are ready to return to nearshore waters. They are usually silvery blue on the upper surface and lighter colored on the lower surface which camouflages them well in the open ocean. They obtain their normal coloration when they recruit to the nearshore reef environment. However, in May of 2004, after the reports of oama being offshore, by June very few had made it inshore. What was also happening during this time was that ocean current patterns appear to have been switching back and forth. This was also reflected in recapture data, perhaps not giving the oama an opportunity to recruit inshore. The oama may have drifted with the uncertain currents to other locations or became food for our bigger open ocean fish. By coincidence, 2004 was a great year for mahimahi. Some fishermen said "it was the best year this decade!" Whatever the case may be, a good oama run for 2004 was just not meant to be.

The Ulua Tagging Data for 2004 has also shown us some interesting effects due to the lack of oama and halalu. Growth rates of tagged omilu (bluefin trevally) that were recaptured between July through December 2004 noticeably dropped. The monthly growth rates of omilu for the months of July 2004 through the end of December 2004 were half of what they were the previous two years (see page 10, Fig. 8). When we looked back to the summers of 2002 and 2003 we had somewhat of an average recruitment of oama which produced omilu growth rates that were as high as 1" per month.

The decline in monthly growth rates seems to be specific to the omilu since the white papio showed their normal growth rates of 1.5" to 2" per month during the same time period. The white papio tend to feed primarily on the introduced sardine, Herklotsichthys quadrimaculatus, along with other prey animals although there is some overlap in diet with the omilu. More tag and recovery data is needed on other carangids to see what effects this change in prey item availability may have had on other species.

Anyway, all of this is just food for thought since we have some interesting information to share with you thanks to all of you for helping us to gather all the data and information. Keep up the good work anglers! As you can see, working together can help solve some of the mysteries of our nearshore resources thanks to all of you participating in the Ulua Tagging Project. Keep up the great work, everyone and let's hope for a good oama run this year for 2005 – our omilu need some food to grow!

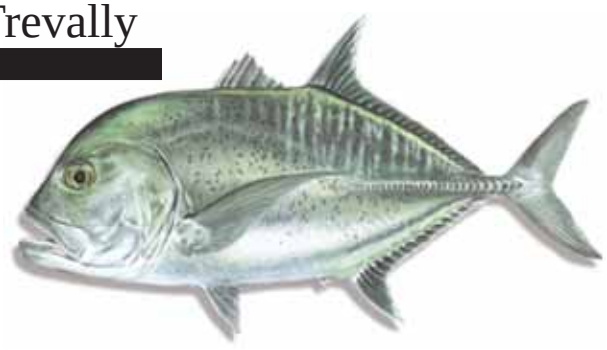
APPENDIX E

Life History Fish Facts on Species Targeted for the DAR Ulua Tagging Project

All species of ulua, papio and kahala are members of the Jack Fish Family which includes other species such as, omaka, opelu, akule, lae, and rainbow runner. These species are considered good food fishes, supporting valuable commercial and sport fisheries in Hawaii. Among the ulua species, juveniles, known collectively as papio, tend to live close to shore for protection, then move toward deeper waters as they get older. This section contains a brief life history review on each of the following fishes which are targetted in the Division of Aquatic Resources' "Ulua Tagging Project". Here you will find basic information on fish sizes, spawning seasons, lifestyles, fishing methods, consumer profiles and growth charts. Growth charts, when available, contain length to weight ratios along with age to size correlations. Please note that these are just ball park figures and meant only to give you a general idea on the relationship of length, weight, and age.

White Ulua, Ulua aukea, Giant Trevally

Caranx ignobilis



SIZES
Length: specimens will reach a length of up to 65 inches
Weight: commonly about 44 pounds, but has been recorded at 191 pounds

BREEDING
Sexual Maturity: females are sexually mature at a standard length of 23.6 inches.
Spawning: between April and November with peaks in the summer.

LIFESTYLE
Distribution: Indo-Pacific: widely distributed throughout most of the Indian Ocean and central Pacific, eastward to the Hawaiian and Marquesas Islands.
Habitat: Young papio are found in brackish-water areas i.e. bays and harbors. Adult fish are found over nearshore reefs; often hiding in caves during the day.
Diet: Feeds on reef fish such as uhu, and eels, also feeds on octopus (tako), lobsters, crabs, and shrimp.
Life Span: approsimately 26.3 years.

FISHING INFORMATION
General: The white ulua in particular is widely considered to be the ultimate shoreline gamefish.
Fishing Methods: Shore Casting, Plugging, Trolling, Handline, Spearing, Nets. White Ulua tend to forage during the evenings and early morning hours. During the day they are usually found in deeper waters, but will sometimes venture near shore when feeding opportunities exist. Smaller fish (ranging between 1 to 3 lbs. in size) are sometimes found in schools which makes them more susceptible to netting.

CONSUMER PROFILE
Meat Type: Medium to firm white meat with a moderate flavor.
Cooking Preparation: Broil, Bake, Fried, Saute, Steam, Smoked, Raw (i.e. sashimi)
*(*Caution: Some of these fish have been associated with ciguatera fish poisoning. If fish poisoning is suspected, call your physician immediately for treatment. For more information about ciguatera fish poisoning, contact the Hawaii State Dept. of Health, Epidemiology Branch.)*

Length, Weight & Age of White Ulua/Papio

Standard Length (inches)	Weight (lbs.)	Age (yrs.)
7	0.3	1
14	2	2
20	5.8	3
25	11.2	4
30	19.3	5
35	30.5	6
39	42.1	7
42	52.4	8
45	64.4	9
48	78	10
51	93.5	11
53	104.8	12
55	117	13
57	130.2	14
59	144.2	15
60	151.6	16
61	159.3	17
62	167.2	18

Largest Recorded in Hawaii: 191 lbs.
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

Omilu, Bluefin Trevally

Caranx melampygus

SIZES
Length: commonly around 24 inches in length; but can get up to 36 inches in length
Weight: can reach up to 30 lbs in weight

BREEDING
Sexual Maturity: fish reach sexual maturity when they reach between 12 to 16 inches in length.
Spawning: spawning occurs between April to November. Fish are sexually mature at 12 to 16 inches fork length

Length, Weight & Age of Omilu

Standard Length (inches)	Weight (lbs.)	Age (yrs.)
8	0.3	1
13	2	2
18	4	3
22	6	4
24	9	5
27	12	6
28	14	7
30	16	8
31	18	9
32	20	10
32.5	21	11
33	22	12
33.5	23	13
34	24	14

LIFESTYLE
Distribution: Indo-Pacific & tropical Eastern Pacific; from Hawaii to central Polynesia, East African Coast to Panama, throughout Micronesia
Habitat: found anywhere from the shoreline all the way to the outer edge of reef areas.
Diet: a hunting predator. Feeds primarily on fishes. Other diet items include a few crustaceans and molluscs.
Life Span: approximately 12.5 years.

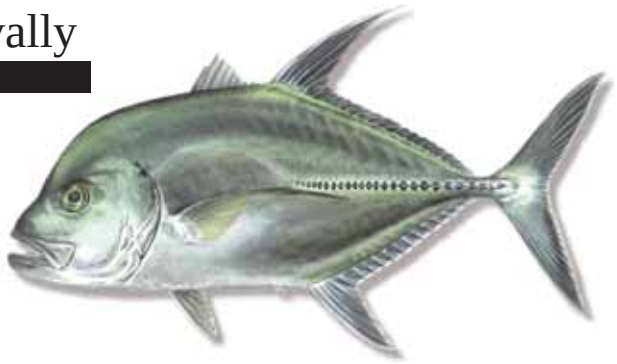
FISHING INFORMATION
General: The omilu is considered a valuable commercial species and an extremely popular game fish among recreational fishermen. Juveniles, known as papio, may be found in small schools swimming around in shallow bays & estuaries. Adults occur singly or in small groups over the inner & outer reef areas.
Fishing Methods: Whipping, Shore Casting, Trolling, Handline, Spearing. Omilu generally forage during the daytime and will usually bite the best during the early morning and late evenings. Omilu will often follow schools of bait fish along nearshore areas.

Largest Recorded in Hawaii:
23 lbs., 6 oz
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

CONSUMER PROFILE
Meat Type: Medium to firm white meat with a moderate flavor. Meat near the head is sometimes wormy with white parasites, but can still be eaten if cooked.
Cooking Preparation: Bake, Fried, Saute, Raw (i.e. sashimi)
*(*Caution: Some of these fish have been associated with ciguatera fish poisoning. If fish poisoning is suspected, call your physician immediately for treatment. For more information about ciguatera fish poisoning, contact the Hawaii State Dept. of Health, Epidemiology Branch.)*

Black Ulua, Gunkan, Black Trevally

Caranx lugubris



SIZES
Length: specimens can reach lengths of up to 39 inches
Weight: can reach up to 35 lbs in weight

BREEDING
Sexual Maturity: fish reach sexual maturity at 15 to 27 inches in total length.
Spawning: Unknown

LIFESTYLE
Distribution: Circumtropical - distributed throughout the tropics worldwide
Habitat: Considered an offshore fish usually seen on the outer reef slopes at depths of over 100 ft., although its depth range is between 21 to 193 fathoms.
Diet: Feeds on fishes at night. Also eats crustaceans.
Life Span: Maximum known age 24 years.

FISHING INFORMATION
General: The black ulua is considered a prize specimen among recreational fishermen not necessarily for its size, but because it's not all that common. It is occasionally caught by deepsea bottomfishermen and very rarely by shoreline fishermen. Often times, the white ulua is commonly mistaken for the black ulua because some of them are nearly black in color, particularly mature males. The black ulua is not actually all black, but more of a dark olive green in color. Other distinguishing characteristics are the presence of black colored scutes, a slightly concave head and elongated secondary dorsal and anal fins.
Fishing Methods: Bottom handline, Shore casting (rarely). Usually found in deep waters, not very common, caught as singles.

CONSUMER PROFILE
Meat Type: Firm white meat with a mild to moderate flavor. In Japan, it is highly prized as a food fish because of its high fat content.
Cooking Preparation: Bake, Fried, Saute, Raw (i.e. sashimi)
*(*Caution: Some of these fish have been associated with ciguatera fish poisoning. If fish poisoning is suspected, call your physician immediately for treatment. For more information about ciguatera fish poisoning, contact the Hawaii State Dept. of Health, Epidemiology Branch.)*

Length, Weight & Age of Gunkan

Fork Length (inches)	Weight (lbs.)	Age (yrs.)
8	0.4	1
12	1.25	2
14	2	3
18	4	4
20	6	5
24	10	7
26	13	8
28	16	10
30	19	12
32	23	14
35	31	19
37	36	22

Largest Recorded in Hawaii:
9 lbs.
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

Menpachi Ulua, Sasa, Bigeye Trevally

Caranx sexfasciatus

SIZES
Length: up to 33 inches or more in length. Maximum length recorded at around 47 inches.
Weight: up to about 15 pounds. Maximum known weight is about 40 pounds.

BREEDING
Sexual Maturity: fish are sexually mature when they reach between 14.2 to 25.5 inches in total length.
Spawning: unknown

LIFESTYLE
Distribution: from Hawaii southward into central Polynesia, westward through Micronesia and Melanesia, through the East Indies, and across the Indian Ocean to the coast of Africa.
Habitat: Inhabits coastal and oceanic waters associated with reefs. Young papio are sometimes found in brackish water areas. Fish may form dense schools during the day while dispersing at night to feed.
Diet: Feeds mainly on fish and crustaceans.
Life Span: approximately 12 years.

FISHING INFORMATION
General: As with any other species of ulua, the menpachi ulua contributes its fair share to sport fishing in Hawaii. Large individuals are usually found in offshore areas while juveniles are found in nearshore areas and sometimes near tide pools and brackish-water.
Fishing Methods: Handline, Shore casting. Generally feeds at night starting early in the evening till morning. Sometimes found near schools of akule, opelu or other bait fish.

Length, Weight & Age of Menpachi Ulua

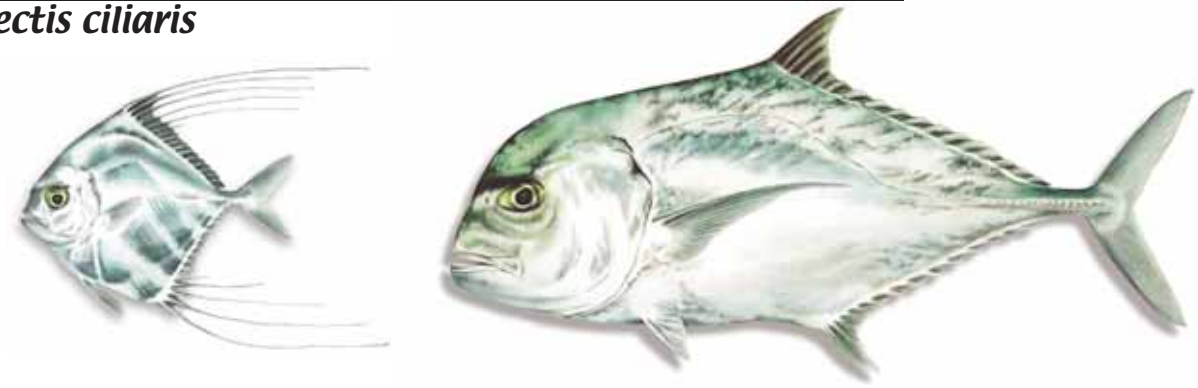
Fork Length (inches)	Weight (lbs.)	Age (yrs.)
10	0.8	1
15	2.7	2
19	5.3	3
22	3	4
24	8.2	5
26	11.2	6
28	13.3	7
29	16.5	8
30	18.3	9
31	20	10
32	21.5	13
33	26	20

Largest Recorded in Hawaii: 15 lbs, 8.8 oz
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

CONSUMER PROFILE
Meat Type: Medium to firm white meat with a moderate flavor
Cooking Preparation: Bake, Fried, Saute, Raw (good sashimi)
*(*Caution: Some of these fish have been associated with ciguatera fish poisoning. If fish poisoning is suspected, call your physician immediately for treatment. For more information about ciguatera fish poisoning, contact the Hawaii State Dept. of Health, Epidemiology Branch.)*

Kagami Ulua, Mirror Trevally, Threadfin Jack

Alectis ciliaris



SIZES
Length: specimens can reach lengths of up to 59 inches.
Weight: can reach up to almost 51 pounds.

BREEDING
Sexual Maturity: fish are sexually mature when they reach between 22.5 to 40.4 inches in length.
Spawning: unknown

LIFESTYLE
Distribution: Worldwide in tropical seas.
Habitat: Juveniles may be found near the shore in bays and shallow waters. Adults more commonly found offshore in midwater to near bottom to depths of 190+ feet.
Diet: Feeds on slow moving crustaceans and occasionally small crabs and fishes.
Life Span: approximately 20.6 years.

FISHING INFORMATION
General: Adult Kagami are caught once in awhile by local fishermen. However, juvenile kagami are better known for their beauty as an aquarium fish with long trailing filaments from its dorsal and anal fins. As these fish age and grow, these trailing filaments shorten in length.
Fishing Methods: Handline, Shore casting, bottom fishing. Tends to like areas with sand and hard bottom. Solitary.

CONSUMER PROFILE
Meat Type: Firm white meat with a delicate flavor.
Cooking Preparation: Fried, Saute
*(*Caution: Some of these fish have been associated with ciguatera fish poisoning. If fish poisoning is suspected, call your physician immediately for treatment. For more information about ciguatera fish poisoning, contact the Hawaii State Dept. of Health, Epidemiology Branch.)*

Length, Weight & Age of Kagami Ulua

Total Length (inches)	Weight (lbs)	Age (yrs)
13	1	1
20	3	2
25	58	3
30	8	4
33	11	5
37	15	6
40	18	7
43	22	8
45	25	9
47	28	10
49	31	11
50	33	12
51	35	13
53	38	14
54	40	15
55	42	17
56	44	18
57	46	20

Largest Recorded in Hawaii: 48 lbs
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

Dobe Papio, Whitemouth Jack

Uraspis helvola

SIZES
Length: specimens can reach lengths of up to 21 inches in total length.
Weight: up to 3 pounds.

BREEDING
Sexual Maturity: Fish reach sexual maturity between 9.7 to 17.5 inches in total length.
Spawning: unknown

LIFESTYLE
Distribution: Southeast Atlantic Ocean (St. Helena and Ascension Islands), Western Indian Ocean (southern Red Sea, off Oman and Sri Lanka), and the Eastern Pacific (Hawaiian and Revillagigedo Islands).
Habitat: Occurs in depths of about 100 to 200 feet often near ledges and dropoff areas.
Diet: Nocturnal feeder, feeding mainly on crustaceans and small fish.
Life Span: approximately 7.9 years.

FISHING INFORMATION
General: Dobe are caught every once in a while by local fishermen usually those who are bottomfishing near the ledge at depths of 100 to 200 feet. These fish have a dark, dusky colored body and are easily identified by the white color of the tongue and the roof of the mouth. The color toward the back of the mouth and the inner surfaces of the gill openings are bluish black.
Fishing Methods: Bottom handline, surround net (sometimes). Caught along dropoffs and ledges, will provide lots of action when schools are found.

CONSUMER PROFILE
Meat Type: White delicate meat with a mild flavor.
Cooking Preparation: Excellent for steaming, baking or frying.

Length, Weight & Age of Dobe Papio

Total Length (inches)	Weight (lbs)	Age (yrs)
5	unknown	1
9	"	2
15	"	3
17	"	4
18	"	5
19.5	"	6
20.5	"	7
21.5	"	8

Largest Recorded in Hawaii:
2.98 lbs.
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

Ulua pa‘opa‘o, Yellow Ulua, Golden Trevally

Gnathanodon speciosus

SIZES
Length: specimens can reach lengths of up to 40 inches..
Weight: can reach up to 30 pounds but is usually around 10 pounds.

BREEDING
Sexual Maturity: fish reach sexual maturity when they reach between 19 to 34 inches in total length.
Spawning: unknown

LIFESTYLE
Distribution: Indo-Pacific and tropical eastern Pacific from Baja California to Peru.
Habitat: Occurs in deep lagoons or seaward reefs in depths of up to 33 feet. Usually seen over sandy bottoms where they feed by rooting for crustaceans and other invertebrates in the sand. Small juveniles may be found living among the tentacles of jellyfish.
Diet: Feeds on various crustaceans and other invertebrates found in the sand. Also feeds on small fishes.
Life Span: approximately 20.6 years.

FISHING INFORMATION
General: Pa‘opa‘o are caught every once in a while by local fishermen and is valued as a food and game fish. Among Hawaiians, this fish is considered the best among the ulua for eating raw.
Fishing Methods: Shore casting, spearing. Caught along harbors, channels and deeper shoreline areas.

CONSUMER PROFILE
Meat Type: Medium white meat with a mild flavor.
Cooking Preparation: Bake, Fried, Saute, Raw.
*(*Caution: Some of these fish have been associated with ciguatera fish poisoning. If fish poisoning is suspected, call your physician immediately for treatment. For more information about ciguatera fish poisoning, contact the Hawaii State Dept. of Health, Epidemiology Branch.)*

Length, Weight & Age of Pa‘opa‘o

Standard Length (inches)	Weight (lbs.)	Age (yrs.)
10	0.75	1
14	2	2
18	4	3
21	6	4
24	8.5	5
26	11	6
29	14.5	7
31	17	8
32	19.5	9
34	22.5	10
35	24.5	11
36	26.5	12
37	29	13

Largest Recorded in Hawaii: 17 lbs, 12 oz
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

Papa, Yellow-Spotted Trevally, Island Jack

Carangoides orthogrammus

SIZES
Length: specimens can reach lengths of up to 28 inches.
Weight: can reach up to 17 pounds.

BREEDING
Sexual Maturity: Fish reach sexual maturity between 12 to 21 inches total length.
Spawning: unknown

LIFESTYLE
Distribution: Indo-Pacific and tropical eastern Pacific: western Indian Ocean to Mexico, north to southern Japan and Hawaii, south to Lord Howe and Astral Islands and throughout Micronesia.
Habitat: common in inshore waters and just beyond the outer reefs. found solitary or in small groups. They occur in depths from 30 ft. to 600 ft., although juveniles can be found in shallower waters.
Diet: Feeds on small benthic crustaceans, worms, and small fishes that live beneath the sand.
Life Span: approximately 10.6 years.

Length, Weight & Age of Papa

Fork Length (inches)	Weight (lbs)	Age (yrs)
9	0.5	1
13	1.5	2
17	3	3
19	4	4
21	6	5
23	7	6
24	8	7
25	9	8
26	10.6	10

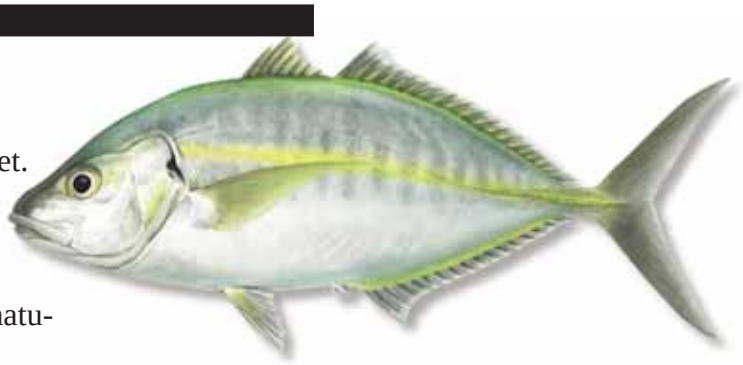
Largest Recorded in Hawaii: 17 lbs, 3 oz
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

FISHING INFORMATION
General: Papa are easy to distinguish from other ulua species by the lemon-colored spots located on each side of the body. These spots appear to be more numerous on smaller individuals and fewer on larger individuals. In some areas, Papa that are over 16 inches in length seem to prefer deeper waters. Papa are not as common as the omilu or white ulua/papio, but they are caught often enough by most fishermen for them to be familiar with this species.
Fishing Methods: Whipping, Shore casting, Bottom Handline, Spearing, Trolling. Found near sand and hard bottom, caught in deeper waters.

CONSUMER PROFILE
Meat Type: Medium to firm white meat with a mild flavor.
Cooking Preparation: Bake, Fried, Saute, Raw, Steam.
*(*Caution: Some of these fish have been associated with ciguatera fish poisoning. If fish poisoning is suspected, call your physician immediately for treatment. For more information about ciguatera fish poisoning, contact the Hawaii State Dept. of Health, Epidemiology Branch.)*

Butaguchi, Buta Ulua, Thicklipped Jack

Pseudocaranx dentex



SIZES
Length: will reach lengths of up to 4 feet.
Weight: up to about 40 pounds.

BREEDING
Sexual Maturity: fish reach sexually maturity between 18.8 to 33.7 inches in total length
Spawning: unknown.

LIFESTYLE
Distribution: Western and Eastern Atlantic and Indo-pacific regions.
Habitat: found at depths between 5 to 100 fathoms.
Diet: Diurnal and nocturnal, feeds on fishes, shrimps, crabs, and octopus.
Life Span: 48.1 years.

FISHING INFORMATION
General: This species is captured primarily by deep sea handline and contributes to bottom fish landings from the Northwestern Hawaiian Islands.
Fishing Methods: Commonly caught on bottom handline. Juveniles sometime caught in harbor channels with rod and reel. Usually found in depths ranging from 180 to 480 feet.

CONSUMER PROFILE
Meat Type: White meat with medium texture and a mild to moderate taste. Meat sometimes on the fatty side.
Cooking Preparation: Bake, Fried, Saute, Steam, Raw (excellent), one of the better eating jacks in Hawaii.

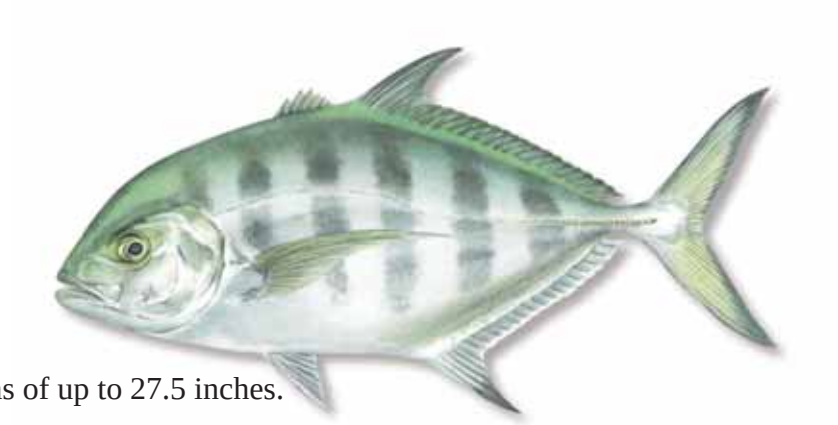
Length, Weight & Age of Butaguchi

Fork Length (inches)	Weight (lbs)	Age (yrs)
11	0.85	1
18	3.74	2
24	9	3
28	14	4
31	19	5
34	25	6
37	33	8
39	38	9
40	41	10

Largest Recorded in Hawaii: 40 lbs
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

Barred Jack

Carangoides ferdau



SIZES
Length: specimens can reach lengths of up to 27.5 inches.
Weight: can reach up to 17 pounds.

BREEDING
Sexual Maturity: Fish reach sexual maturity between 14.4 to 25.8 inches in total length.
Spawning: unknown

LIFESTYLE
Distribution: Indo-West Pacific: widely distributed from the Red Sea and East Africa to the Hawaiian Islands.
Habitat: Occurs in coastal waters near sandy beaches and reefs. Also found in depths of about 196 feet often near reefs.
Diet: Feeds mainly on crustaceans, mollusks and small fish that are abundant in the lagoons.
Life Span: approximately 13.7 years.

FISHING INFORMATION
General: Barred jacks are caught every once in a while by local fishermen. They are generally caught offshore and occasionally by shoreline fishermen.
Fishing Methods: Near shore handline, shore casting. Usually caught near flat areas surrounding outer reefs and sometimes caught in harbor areas.

CONSUMER PROFILE
Meat Type: White delicate textured meat with a mild taste.
Cooking Preparation: Bake, Fried, Raw, Steam.
*(*Caution: Some of these fish have been associated with ciguatera fish poisoning. If fish poisoning is suspected, call your physician immediately for treatment. For more information about ciguatera fish poisoning, contact the Hawaii State Dept. of Health, Epidemiology Branch.)*

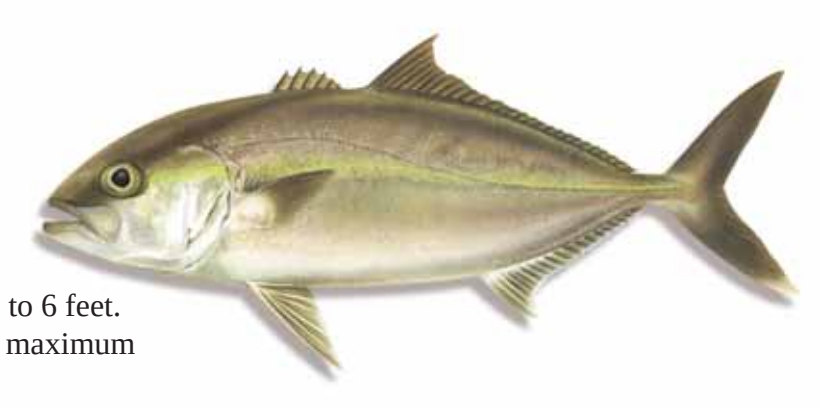
Length, Weight & Age of Barred Jack

Fork Length (inches)	Weight (lbs)	Age (yrs)
8	0.5	1
12	1.5	2
16	3	3
19	5	4
21	7	5
22	8	6
24	10	7
25	11	8
26	12	9
27	13	10
27.5	14.5	11
28	15	12
28.75	16	13
29	16.5	14

Largest Recorded in Hawaii: 8.09 lbs.
(source: Hawaii Fishing News Hawaii State Record Fish Captures)

Kahala, Amberjack

Seriola dumerili



SIZES
Length: will reach a length of up to 6 feet.
Weight: up to about 120 pounds; maximum known weight is 178 pounds.

BREEDING
Sexual Maturity: females generally reach sexual maturity at 21.3 inches fork length.
Spawning: spawning occurs throughout the year with a peak in April.

LIFESTYLE
Distribution: Circumglobal. Indo-west Pacific, South Africa to Hawaii.
Habitat: Inhabits deep seaward reefs. Usually inhabits the inner reef as well as the outer slopes of the island shelf.
Diet: Diurnal and nocturnal, feeds on fishes, squids, and other invertebrates.
Life Span: maximum known age in captivity is 4.5 years.

FISHING INFORMATION
General: Kahala is a good food fish, however, it has been implicated in many incidents of ciguatera fish poisoning and should be tested before eating.
Fishing Methods: Deep sea handline, shore casting, spearing, trolling. Sometimes found nearshore around schools of fish such as akule or halalu. Usually found offshore in deeper waters associated with structures such as ledges and dropoffs.

CONSUMER PROFILE
Meat Type: White medium textured meat with a moderate flavor. Meat sometimes wormy with parasites, still edible if cooked.
Cooking Preparation: Bake, Fried, Saute, Raw.
*(*Caution: Some of these fish have been associated with ciguatera fish poisoning. If fish poisoning is suspected, call your physician immediately for treatment. For more information about ciguatera fish poisoning, contact the Hawaii State Dept. of Health, Epidemiology Branch.)*

Length, Weight & Age of Kahala

Fork Length (inches)	Weight (lbs)	Age (yrs)
15	1.9	1
27	10.7	2
36	25	3
42	39	4
46	51	5
50	65	6
52	73.4	7
54	82	8
55	86.6	9
56	91	10
57	96	11
58	101	14
60	112	14+

Largest Recorded in Hawaii: 145.5 lbs.
(source: Hawaii Fishing News Hawaii State Record Fish Captures)