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Appendix A

JOHNSTON ATOLL RESOURCE SURVEY
FINAL REPORT - PHASE SIX
(21 JUL 89 - 20 JUL 90)

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JOHNSTON ATOLL RESOURCE SURVEY
FINAL REPORT - PHASE SIX
(21 JUL 89 - 20 JUL 90)

INTRODUCTION

Construction of the Johnston Atoll Chemical Agent Disposal System (JACADS) project has been completed, and operations began in June 1990. The potential for adverse environmental effects is a concern, which has been addressed in environmental impact statements (U.S. Army Corps of Engineers 1983, 1985). This concern has led to a number of studies of the atoll's surrounding environment and biota (Applied Eco-Tech Services, Inc. 1983; Balazs 1984; Irons et al. 1984; Lobel 1984, 1985; Agegian and Abbott 1985; Dee et al. 1985; Keating 1985; Randall et al. 1985; Irons et al. 1986; Irons et al. 1987, 1988, 1989). There have been several previous studies of elements of the Johnston Atoll lagoon flora and fauna (Smith and Swain 1882; Edmondson et al. 1925; Fowler and Ball 1925; Clark 1949; Schultz et al. 1953; Halstead and Bunker 1954; Gosline 1955; Banner and Helfrich 1964; Moul 1964; Brock et al. 1965, 1966; Buggeln and Tsuda 1966; Jones 1968; Brock 1972, 1982; Bailey-Brock 1975; Amerson and Shelton 1976; Jokiel 1976; Maragos and Jokiel 1986). A systematic survey of the nature and distribution of the living aquatic resources is of particular concern because of the status of Johnston Atoll as a National Wildlife Refuge.

The first portion of the initial study (Irons et al. 1984) was designed to characterize, describe and evaluate the shallow-water ecosystem of the atoll as a whole, in an attempt to better assess its environment and resources. This included identifying the zones or "ecotypes" (Fig. 10), based on physical and biological similarities, that appeared distinctive within the atoll ecosystem (Irons et al. 1984).

The second portion of the initial study (Dee et al. 1985) had two distinct but related objectives: 1) detailed resource measurement and status monitoring, and 2) assessment of the nature and level of harvest. Subsequent work during Phase Two (Irons et al. 1986), Phase Three (Irons et al. 1987), Phase Four (Irons et al. 1988), Phase Five (Irons et al. 1989), and the present phase (Phase Six) have continued with the same objectives. The detailed resource measurement and status monitoring is intended to obtain more complete and quantitative abundance, distribution, and population characteristic data for the non-cryptic macrofauna within a representative set of long-term monitoring stations. Using standardized methods, the resources at the long-term stations have been monitored periodically to detect differences in the resource populations as JACADS progresses.

To the extent that spatial patterns of fishing/collecting activity permit, it is desirable to maintain a pair of physically and ecologically similar stations, one with a fairly high present level of harvest and one with a low level. Differences over time in the unharvested monitoring station will reflect changes unrelated to harvest - either natural variability or changes

1 (pages 2-4 not included)

abundance and distribution of cryptic species, such as soldierfish and bigeyes. These were conducted by searching all possible hiding places where cryptic species may be found throughout two areas of 900 m^2 each, within a station.

The overall area characterization consisted of a quantitative estimate of percent algal and coral cover (corals by species), invertebrate abundances, and physical characteristics of the station area. Overall characterization methods were basically as in Irons et al. (1984) except that a numerical value was assigned for bottom coverage of most sessile forms (Appendix A).

To assess the fishery at Johnston Atoll, two methods were used: 1) fishermen's catch reporting, and 2) creel census. The catch reporting program was started in February 1984, and has been ongoing throughout the project whenever fishing was permitted. Boxes containing catch report forms (Appendix B, Fig. 1) were placed at the six most frequently fished locations on Johnston Island: port control, Hama point, Hashi's shack, the east and west ends of the main pier, and the boathouse (between port control and the main pier) (Fig. 1). Catch reports provided information on species and numbers of animals caught and/or collected: date, time, and location caught/collected; amount and types of gear used; hours spent fishing; and identity of fishermen. A catch report was requested each time anyone did any kind of fishing and/or collecting, even if there was no catch. The catch report format was designed and the report boxes were located and maintained so as to make the reporting process as simple and painless as possible for all fishermen. Consistent and accurate catch reporting was constantly stressed by Unit project staff. Serious declines in voluntary catch reporting during the report year ending 1987 resulted in the implementation of a new form (Appendix B, Fig. 2) combining recreational boat sign-out procedures with a mandatory catch report to be filled out upon the fisherman's return. A serious decline in JI shoreline catch reporting during the report year ending 1989 made this shoreline information unusable. Subsequently, Unit personnel and Island management personnel have been unable to determine a satisfactory method of enforcing mandatory reporting of JI shore catch. As a result, no data for JI shore catch will be reported. However, Unit personnel continue to encourage JI shore catch reporting and continue to collect the completed JI shore catch forms.

Creel census was performed by the Unit project staff on catches made by fishermen. It consisted of recording pertinent data, such as numbers of each species caught, weights, lengths, and sex (if discernible) of specimens, date, gear used, and the names of fishermen. Catches involving the use of boats were censused at the boathouse. Due to the work schedule of Johnston Atoll people, approximately 70% of all fishing occurs on Sundays. For this reason creel census was routinely conducted only on Sundays. This allowed a significant portion of the harvest to be examined with minimum time and effort.

5 (pages 6-24 not included)

considerably reduced the negative trend in "mean total number per census" (Table 3). By extension, variability of recruitment occurring for a good many species might contribute heavily to the overall population pattern observed.

All the community analyses combined showed no clear seasonal variations in the fish communities at the monitoring stations. However, there were differences in the fish communities between stations. Stations P3 and P7, which are both located in different habitat types from Stations P1, P5, and P6, have very different fish communities. Station P3 has a significantly lower mean number (as determined by paired t-tests) of total individuals observed on the fish transect censuses when compared to Stations P1, P5, and P6. In some previous phases of this study and in the present phase, Station P7 has had a significantly higher number (as determined by paired t-tests) of Ctenochaetus strigosus and Acanthurus nigroris juveniles than any other station. Station P5 showed no significant differences from Stations P1 and P6 in the t-tests and dendrograms, but it is the only place where the whitecheek surgeonfish (Acanthurus glaucopareius) is seen.

In addition, paired t-tests were performed on some species that are often important in the catch (i.e., Myripristis amaenus, the doublebar goatfish (Pseudupeneus bifasciatus), the manybar goatfish (P. multifasciatus), the blue goatfish (P. cyclostomus), the Samoan goatfish (Mulloides flavolineatus), the rudderfish (Kyphosus vaigiensis), the blue jack (Caranx melampygus), the spectacled parrotfish (Scarus perspicillatus), and Acanthurus triostegus) seen at Stations P5 and P6. These results also showed no significant differences between these two stations. The lack of significant differences between these stations, with similar habitats and substantially different fishing effort, is consistent with the harvest assessment results in suggesting that there is no significant impact on the fish communities at Johnston Atoll from the present level of fishing.

THE FISHERY

General Characteristics

All fishing at Johnston Atoll (JA) is supposedly for recreational purposes. The majority of the fishing activity and a very large fraction of the finfish catch is due to long-term "residents" - almost all employees of Holmes and Narver, the prime contractor for JA operations. These fishermen fish mostly for enjoyment, to add fresh fish to their diet, and to accumulate fish to freeze and carry home when they take home leave from JA at infrequent intervals. The remainder of the catch is due to "transients" - personnel stationed for one to two years at JA, such as military personnel, and the employees of various JACADS contractors. As a rough estimate, 350 boxes of frozen fish are "exported" annually for home leave. During years of good deep-sea fishing conditions, a majority of these boxes may contain deep sea fish, primarily wahoo (Acanthocybium solandri). Most of the "exported" fish terminates in Honolulu. There is no definite

information as to how it is disposed of. While there are no subsistence implications to the consumption of fish locally at JA, eating fresh caught fish is clearly an important recreational and social activity for a number of residents. There is apparently little waste of the total fish catch. Many fishermen give fish to nonfishermen to take home on leave. There is no monitoring or control of "export". Coral and gastropods are taken by both residents and transients. Disposition of these and most other invertebrate species appears to be for personal collections, or they are used as gifts for family and friends. The following is a brief description of the nature of the fishery for some of the species (fish and invertebrates) that were major items in the catch when the study began.

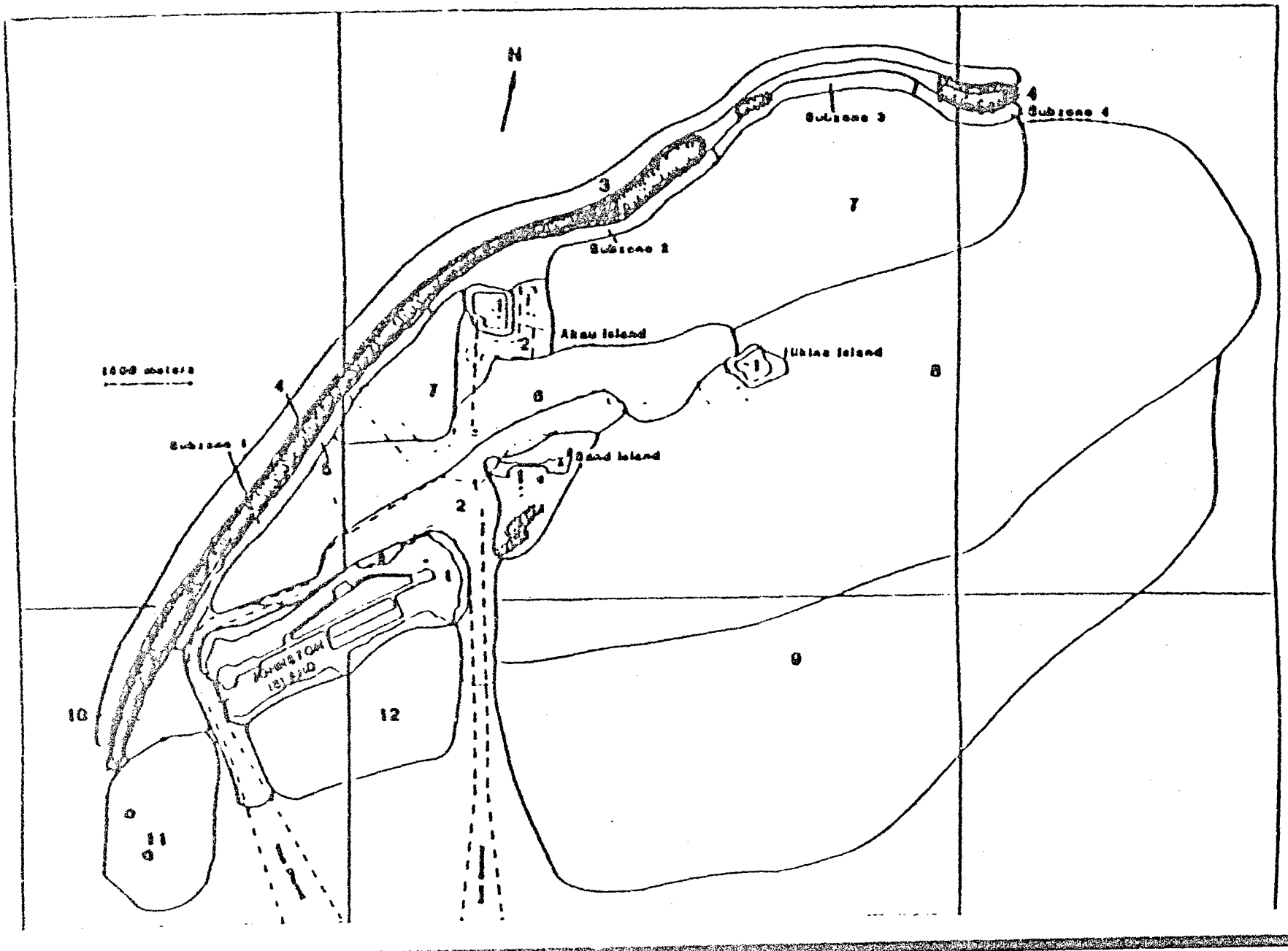
Myripristis amaenus, the most common of the "menpachi", constitutes the largest catch in numbers of all fish species at JA. Large numbers of this soldierfish are taken by fishermen throughout the year. Prime areas for nighttime line fishing for menpachi include Hama point and Red Hat seawall on Johnston Island (JI), as well as at the Sand Island pier (Fig. 1). During the day, large numbers of menpachi are taken by spear throughout Zones 5 and 10 (Fig. 10), with most taken in the vicinity of Station P5. No menpachi are taken by net. Menpachi fishing, like most fishing at JA, is done almost exclusively by residents. Most menpachi taken is used for local get-togethers, or is frozen by fishermen for home leave export.

Priacanthus cruentatus or "aweoweo" is one of the most prized fish species at JA. Bigeyes are taken at night by line from several locations on Johnston Island - main pier, Hama point, Red Hat seawall - as well as from the Sand Island pier. During the day, they are occasionally taken by spear throughout Zone 5, with most of these taken in the vicinity of Station P5. No aweoweo are taken by net. Aweoweo fishing is done almost exclusively by residents. They are taken in small numbers most of the year. Occasionally (only a few times a year, usually in January and February), they are taken in large numbers. When this occurs, many fishermen go to the main pier at night to fish exclusively for aweoweo, which usually bite heavily for one or two days. Aweoweo are usually frozen for home leave export.

Kuhlia marginata or "aholehole" and Chaenomugil leuciscus or "uouoa" are taken almost exclusively by throw net. Schools of these flagtail and mullet frequent the shallow rubble flats around the shorelines of Akau, Hikina, and Sand Islands, and occasionally Johnston Island. There are a few regular throw net fishermen (all residents) who take these species in large numbers. Thus small changes in the fishing activity of these fishermen can produce wide fluctuations in the annual catch figures for these species. They are either eaten locally, given to others, or frozen for home leave export.

Kyphosus vaigiensis or "nenue" are taken by line and spear mostly from JI. Rudderfish taken by residents are usually consumed; those taken by transients are considered incidental catch and are either used as bait or are returned alive.

Mulloidichthys flavolineatus or "weke" are taken using all three gear types - line, spear, and net - from shallows around all islands and occasionally from Zone 5. During the summer months,


N
Subzone 3
4
Subzone 4
3
7
Subzone 2
Akau Island
Ulaino Island
8
1000 meters
4
7
8
Subzone 1
Sand Island
2
1
JOHNSTON ISLAND
9
10
12
11

juvenile weke or "oama" are taken in large numbers by throw net from the shallows around the islands. Approximately 50% of all weke taken are oama. Residents, mostly throw netters, take the majority of weke, with transients taking small numbers by line fishing. This goatfish is eaten locally or given away for home leave export. Juveniles are often collected for use as bait.

Pseudupeneus bifasciatus or "moano papa" is a prized fish species at JA and is taken almost exclusively by residents by line fishing or spearing. Line fishing for moano papa is done by boat along the channel edges, primarily the north edge of the main channel. This goatfish is taken by spear throughout Zones 5 and 10, mostly from the vicinity of Station P5. Moano papa are usually frozen by fishermen for their own home leave export.

Pseudupeneus cyclostomus or "moano kea" are highly prized at JA. A large part of the catch is taken by residents using lines or spears. Most moano kea are taken along the edges of the main channel; many are also taken from rubble shoreline areas around Johnston Island. This goatfish is speared throughout Zones 5 and 10, with most taken in the vicinity of Station P5. Moano kea are usually frozen for home leave export.

Pseudupeneus multifasciatus or "moano" are taken almost exclusively by residents, by line fishing along the channel edges, with some also taken from Johnston and Sand Island shorelines. This goatfish is speared throughout Zones 5 and 10, with most taken in the vicinity of Station P5. Most moano are frozen for home leave export.

Caranx melampygus and Forskal's jack (Carangoides orthogrammus), known locally as "papio" (those under 10 lbs.) or "ulua" (those over 10 lbs.), are taken mostly by residents and some transients by line fishing along channel edges, or from several locations on Johnston Island, as well as from Sand and East Island piers. These jacks are only occasionally taken by spear, usually in the vicinity of Station P5. Most papio are frozen for home leave export.

Scarus perspicillatus or "uhu" are taken predominantly by residents using spears. This parrotfish is speared throughout Zones 5 and 10, with some also taken around Sand and Johnston Island shorelines. Uhu are prized by fishermen and are usually frozen for home leave export.

Acanthurus triostegus or "manini" are taken exclusively by residents using throw nets, or spears. About 40% of the total catch is taken by throw nets around the shallows of all islands. Spearing, which accounts for the remaining 60% of the total catch, is done throughout Zones 5 and 10, with most fish taken in the vicinity of Station P5. This surgeonfish is usually eaten at local get-togethers or given to others for home leave export.

Ctenochaetus strigosus or "kole" are taken almost exclusively by residents. Practically all are taken by spear from Zones 5 and 10, primarily in the vicinity of Station P5. This surgeonfish is also eaten locally or is given to others to freeze for home leave export.

Acropora cytherea or "tabletop coral" is frequently collected by hand by both residents and transients. Most A. cytherea colonies collected are ~15-30 cm in diameter. This coral is commonly used for making coral trophy boxes. Most A.

cytherea is taken in the vicinity of Station P5, but it is also taken from other locations throughout the lagoon. Other species of coral, including Pocillopora sp. and Millepora are taken in much smaller numbers for similar purposes.

The red coral (Distichopora sp.) is prized by collectors and is primarily used for decorative purposes such as coral boxes. It is taken by hand throughout Zone 4 by both residents and transients. It is somewhat scarce in various sections of Zone 4, especially from Station P5 northward toward Station P6 (Irons et al. 1984), but is abundant in areas inaccessible to collectors (outside the barrier reef).

The mushroom coral (Fungia [P.] scutaria), the sea urchin (Echinothrix calamaris/diadema), and various gastropods such as augers, cones and small cowries occur in Zone 5 and other locations throughout the lagoon. These are collected by hand by both residents and transients, and are used for decorative purposes.

The tiger cowrie (Cypraea tigris) is prized by residents and transients and is used for decorative purposes. C. tigris is taken by hand throughout Zone 4, mostly from the reef-top around and between Stations P5 and P6. It is somewhat scarce and scattered throughout Zone 4.

Octopus sp. or "tako" are prized by residents and are occasionally found in the rubble of shallows along the shorelines of all four islands. Tako are speared or hand collected and are usually eaten locally.

The spiny lobster (Panulirus penicillatus) is taken by hand exclusively from Zone 4 and is highly prized by both residents and transients. Any P. penicillatus taken are usually eaten locally.

The crab (Grapsus sp.) is collected by hand and eaten exclusively by residents. It is found along stretches of all the island shorelines. Only a few people occasionally collect this crab.

Many other fish and some invertebrate species produce small catches of some minor recreational value.

Correction for Underreporting of Catch

The basic quantitative data used to estimate catch came from fishermen's catch reports. There was substantial underreporting, and adjustments were made in an attempt to obtain a reasonable approximation of the annual catch. Fishing involving use of boats includes all fishing done on and around Akau, Hikina, and Sand Island, as well as all fishing done directly from boats. Underreporting of fishing done by boat was estimated by counting the catch report forms that were turned in not completed by fishermen who used boats. (Catch reports are now located on the back of the boathouse "boat check-out" records (Appendix B, Fig. 2) that are filled out for the recreation department each time a boat is used). Since it is mandatory for everyone who checks out a boat to fill out the catch form on the back, a single estimate of underreporting was calculated for all species caught using boats. During the current report year, 77% of all boats that

were checked out for fishing reported on catch. Thus, we estimated that 77% of the catch of each species was reported. Catch data recorded from JI shore fishing were neither analyzed nor reported because there is no means for estimating underreporting, which is known to be substantial.

Annual Catch and Effort

The total boat catch of each species, for the period Jun 89 to May 90 (year ending 1990), corrected for underreporting, is shown in Table 5, including major gear types used and primary location(s) of catch. The first 13 species listed were those that initially provided the largest catches. For historical reasons, this group continues to be referred to as the "major catch species", and most of these species have provided important landings in most years of the study. In the last few years, catches of Kyphosus vaigiensis have been very low (zero by boat in the current year), and catches of Carangoides orthogrammus, Selar crumenophthalmus, and Decapterus macarellus have been as high as many of the "major catch species".

Table 5. Estimated total annual boat catch of all species reported in the JA fishery, including major types of fishing gear and locations of catch, for Jun 89 - May 90.

FISH SPECIES[1]	TOTAL NUMBER CAUGHT	MAJOR GEAR TYPE[2]	PRIMARY LOCATION(S)[3]								
			AI	HI	SI	PI	PS	Z6	Z10	CH	LA
Myripristis [illegible]	3362	LI SP		HI		227	2047		690		375
Ctenochaetus strigosus	1201	SP	596	HI		PI			161		385
Acanthurus triostegus	828	SP HT	112	521					172		LA
Chaetodon [illegible]gii leucisecus	509	HT	112	392							
Kuhlia marginata	225	LI HT	65	160							
Caranx [illegible]	186	LI SP	24	110	SI					CH	LA
Pseudocaranx cyclostomus	129	LI SP	AI	73	SI					CH	
Mullioides flavolineatus	123	LI SP HT	56	69	SI						
Scarus perspicillatus	83	SP	56	18					210		18
Pristipomoides [illegible]	79	SP	20						52		LA
Pseudocaranx bifasciatus	66	LI SP	56						210	CH	LA
Pseudocaranx multifasciatus	58	LI SP	AI	HI	SI					CH	LA
Kyphosus vaigiensis	0	.									
Selar crumenophthalmus	593	LI HT	31	566							
Carangoides orthogrammus	157	LI SP	30	102	SI					CH	LA
Acanthurus [illegible]	26	LI		HI							
Acanthurus nigricans	16	SP	AI								
Balistes sp.	13	LI									LA
Aphareus furca	5	LI		HI							
Aulostomus chinensis	2	HT		HI							
Carcharhinus [illegible]	2	LI		HI							
Scomberoides lysan	2	LI		HI							

Table 5 (continued).

BENTHIC SPECIES[1]	TOTAL NUMBER CAUGHT	MAJOR GEAR TYPE[2]	PRIMARY LOCATION(S)[3]								
			AI	MI	SI	P1	P5	Z6	Z10	CH	LA
Corals											
Acropora cytherea	456	HC					P5				
Diatichopora sp.	402	HC						Z6			
Fungia scutaria	135	HC	AI								LA
Acropora valida	108	HC					P5				
Millepora tenera	4	HC							Z10		
Non-sessile invertebrates											
Octopus sp.	121	SP HC	AI	MI					Z10		
Penutirus penicillatus	74	HC						Z6			
Linckia sp.	14	HC									LA
Gracosus sp.	8	HC	AI								
Cypraea tigris	57	HC						Z6			
Terebra sp.	36	HC	AI		SI						
Conus sp.	8	HC						Z6			
Charonia tritonis	7	HC						Z6	Z10		
Cypraea sp.	5	HC									LA

[1] See Appendix A for common names.

[2] Gear abbreviations:

LI : Line
SP : Pole spear
HC : Hand collected
NT : Throw net

[3] Location abbreviations:

AI : Shoreline and/or shallow waters around Akau Island
MI : Shoreline and/or shallow waters around Nikina Island
SI : Shoreline and/or shallow waters around Sand Island
P1 : Long-term Station P1 and adjacent similar areas
P5 : Long-term Station P5 and adjacent similar areas
Z6 : Zone 6
Z10: Zone 10
CH : All channels
LA : Elsewhere in JA lagoon within the shallow platform atoll area.

Note : For species with a substantial total number caught in more than one location, the number caught in each major location is shown.

Some fishing and collecting have occurred throughout all areas of the lagoon where boat use is permitted and at all the islands of JA. However, there are a number of locations that are fished much more than others.

Trolling and bottom fishing are done in all the channels. About 95% occurs along the north edge of the main channel and turning basin from Hama point around JI to the garbage chute. Catch from the channels consists primarily of Caranx melampygus, Carangoides orthogrammus, Pseudupeneus multifasciatus, P. cyclostomus, and P. bifasciatus. There are only a few fishermen who fish this area once and occasionally twice a week.

Another location that receives considerable fishing pressure from spearfishermen and coral collectors is the area between the north edge of Akau Island and the barrier reef, extending from Station P5 west to the NW corner of Akau Island. Very little line fishing occurs in this area. Major catch species are Myripristis amaenus, Ctenochaetus strigosus, Pseudupeneus multifasciatus, P. bifasciatus, Acanthurus triostegus, and Priacanthus cruentatus. Acropora cytherea, Cypraea tigris, and Panulirus penicillatus are the primary hand collected species from this area.

The area in Zone 10 between the west edge of the main channel and the barrier reef, extending past the west camera stand to the SW end of the barrier reef, receives a moderate amount of fishing pressure. Major catch species taken are Ctenochaetus strigosus, Pseudupeneus bifasciatus, P. multifasciatus, P. cyclostomus, Acanthurus triostegus, and Scarus perspicillatus. Most are speared, but some are taken with lines from the channel edge near Station P3. The reef flat immediately adjacent to the west camera stand is regularly visited by fishermen looking for octopus.

The area around and containing Station P1 is occasionally visited by spearfishermen and collectors. Major catch species from this area are Myripristis amaenus, Priacanthus cruentatus, Ctenochaetus strigosus, and Scarus perspicillatus. Less fishing occurs here during winter months due to strong surge and currents resulting from large surf breaking just outside the reef. The region of Zone 5 extending from Station P5 to P6 and Donovan's Reef is occasionally visited by spearfishermen and collectors. Major catch species from this area are Ctenochaetus strigosus and Myripristis amaenus. Hand collected species are Cypraea tigris, Panulirus penicillatus, and Diatichemora sp.

Various locations around Johnston Island receive a considerable amount of fishing pressure. The main pier is line fished for Caranx melampygus, Carangoides orthogrammus, Pseudupeneus cyclostomus, and Priacanthus cruentatus when barge traffic allows. The port control pier, which formerly was line fished for Myripristis amaenus, is now off limits to fishing. During the day, Pseudupeneus cyclostomus, P. multifasciatus, and occasionally Octopus sp. are taken primarily by line along the shoreline from the Point house to the southeast corner of JI. Myripristis amaenus and Priacanthus cruentatus are taken by line and are the major catch species from Hama point. Throw nets are occasionally used along the shoreline from Hama point to the West point to take Acanthurus triostegus and Chaenomugil leucosagus.

At night the Red Hat seawall is line fished for Myripristis amaenus, the big-scale soldierfish (Myripristis berndti), and Priacanthus cruentatus. Hashi's shack is line fished for the needlefish (Platybelone argalus) and Scarus perspicillatus. The grey reef shark (Carcharhinus amblyrhynchos) is also occasionally taken by military personnel using handlines from Hashi's shack and Hama point. The white-tipped reef shark (Triaenodon obesus), which was formerly caught at these sites, is now protected by an FCJ regulation. The garbage chute, formerly a popular fishing site, has been condemned due to structural damage by a storm. Fishing previously done at the garbage chute is now done at nearby Hashi's shack on the west wharf. However, some shark fishermen have been frequenting the garbage chute again.

Sand Island also receives some line and net fishing pressure. At night the pier is line fished for Myripristis amaenus and Priacanthus cruentatus. Caranx melampygus and Carangoides orthogrammus are occasionally taken there also. During the day, throw netters take Acanthurus triostegus, Kuhlia marginata, and Chaenomugil leuciscus from the shorelines around the east part of Sand Island.

Akau and Hikina Islands are frequented by throw netters taking Acanthurus triostegus, Chaenomugil leuciscus, Kuhlia marginata, and Mulloides flavolineatus. Pseudupeneus cyclostomus, Caranx melampygus, and Carangoides orthogrammus were also taken by line from the Hikina Island pier. These islands are off limits for all human visitation most of the year due to the large numbers of nesting seabirds there.

Weather permitting, all the locations above are easily accessible to fishermen. Locations in Zone 5 are somewhat less accessible due to occasional strong currents and surge. The areas around Stations P1, P3, P5 and P6 are visited primarily by divers spearing and/or hand collecting. Very little, if any, line fishing occurs at or near these areas. The channel areas are fished almost exclusively using lines, with some spearing occurring along the channel edge near Station P3. Line fishing from shore on JI is done at all the locations mentioned above. There is a low level of throw netting on JI done by a handful of regular fishermen.

A more detailed breakdown for annual catch of the 13 "major catch species" is presented in Table 6. Catch was separated by gear types. Catch, effort, and catch per unit effort (CPUE) were calculated for each situation.

Table 6. Estimated annual boat [1] catch, effort, and catch per unit effort (CPUE) of the 13 "major catch species" in the JA fishery for the period Jun 89 - May 90, broken down by gear type.

SPECIES	GEAR TYPE: LINE	SPEAR	THROW NET	TOTAL
Myripristis amoenus (Brick soldierfish)				
CATCH[2]	65	3297		3362
EFFORT[3]	29	737		
CPUE[4]	2.24	4.47		
Priacanthus cruentatus (Bigeye)				
CATCH		79		79
EFFORT		194		
CPUE		0.41		
Kuhlia marginata (Hawaiian flagtail)				
CATCH	38		187	225
EFFORT	28.5		30	
CPUE	1.33		6.23	
Kyphosus vaigiensis (Rudderfish)				
CATCH				0
EFFORT				
CPUE				
Mulloides flavolineatus (Yellowstripe goatfish)				
CATCH	35	29	64	128
EFFORT	98	82.5	21	
CPUE	0.36	0.35	3.05	
Parupeneus bifasciatus (Doublebar goatfish)				
CATCH	6	60		66
EFFORT	26	131		
CPUE	0.15	0.46		
Parupeneus cyclostomus (Blue goatfish)				
CATCH	124	5		129
EFFORT	429	18		
CPUE	0.29	0.28		
Parupeneus multifasciatus (Manybar goatfish)				
CATCH	31	7		38
EFFORT	226	10.5		
CPUE	0.14	0.67		

Table 6 (continued).

SPECIES	GEAR TYPE: LINE	SPEAR	THROW NET	TOTAL
Caranx melampygus (Blue jack)				
CATCH[2]	177	9		186
EFFORT[3]	506	41		
CPUE[4]	0.35	0.22		
Chaenomugil leuciscus (Chaotall's mullet)				
CATCH			509	509
EFFORT			81	
CPUE			6.28	
Scarus perspicillatus (Spectacled parrotfish)				
CATCH		74	9	83
EFFORT		145	15	
CPUE		0.51	0.60	
Acanthurus triostegus (Convict surgeonfish)				
CATCH		480	348	828
EFFORT		222.5	45.5	
CPUE		2.16	7.65	
Ctenochaetus striatus (Yellow eyed surgeonfish)				
CATCH		1201		1201
EFFORT		359		
CPUE		3.34		
GRAND TOTAL FOR MAJOR SPECIES IN CATCH				
CATCH	474	5241	1117	6832
EFFORT	1342.5	1940.5	192.5	
CPUE	0.35	2.70	5.80	

[1] Any fishing from shores of islands other than it involved the use of boats and is reported here.
[2] Catch in number of individuals.
[3] Effort units:
Line : line-hours
Spearing : spear-hours
Throw netting : throw net-hours
[4] Catch per unit effort:
Line : number of fish per line-hour
Spearing : number of fish per spear-hour
Throw netting : number of fish per throw net-hour

Catch and effort were highly variable among species, and for most species, they were highly variable over time. Most of the CPUE values for individual species from the year ending 1990 were generally within the range of the corresponding values from the previous years of the study (Table 7). However, all the CPUE values were highly variable with no clear trends between the years.

Total catch has varied considerably over the 6 years of the study (Table 7) as well as the subtotals by each type of gear (Fig. 11-13). No particular temporal pattern is recognizable. However, for most of the total time series for each gear type, the pattern of fishing effort corresponds rather closely with that of catch. Therefore, CPUE, which is sometimes used as an indicator of fish abundance, is much less variable than catch. CPUE for each gear type is considerably more stable for all species combined than for most single species. It shows no meaningful temporal trend for any of the gear types. CPUE's for spearing and netting (Fig. 11-12) seem to vary randomly above and below their initial values. The CPUE for line fishing (Fig. 13) decreases irregularly. These temporal patterns and the limited range of CPUE values for each gear type suggest that the year-to-year fluctuations in catch primarily reflect fluctuations in effort.

Effort and CPUE may have been noticeably affected by some observable shifts in the fishermen's fishing patterns in recent years. Several of the "resident" fishermen have retired and left JA in the past two years. Other "resident" fishermen have stated that they have been "taking a break" from fishing and have only gone fishing a few times in the past two years. Competition by increasing numbers of "transient" SCUBA divers (who seem to catch little) for the use of the limited supply of boats at JA appears to have reduced the amount of productive effort by experienced, skilled fishermen. Other fishermen new to JA have been replacing the older "resident" fishermen in the fishery, but these new fishermen do not seem to catch as much as the "resident" fishermen did. A decrease in CPUE may have resulted, especially where consistent line fishermen have left JA for good. The "resident" fishery has been shifting to mostly a few groups of spear fishermen. Consequently, some of the species previously caught mostly by line fishing were collected in low numbers this report year, while some of the spear catches were high. Overall, there are now fewer fishermen who catch a high volume of fish. Inconsistent reporting of catch and effort, months of bad weather (especially in the years ending 1985 and 1986), as well as the home leaves, travel and work schedules of "resident" fishermen all can have significant effects on this small fishery.

Clearly there are some unresolved anomalies in the catch and effort data. However, all the catch and effort data together do not produce any consistent trends that would indicate any major change in abundance of the resident fished populations.

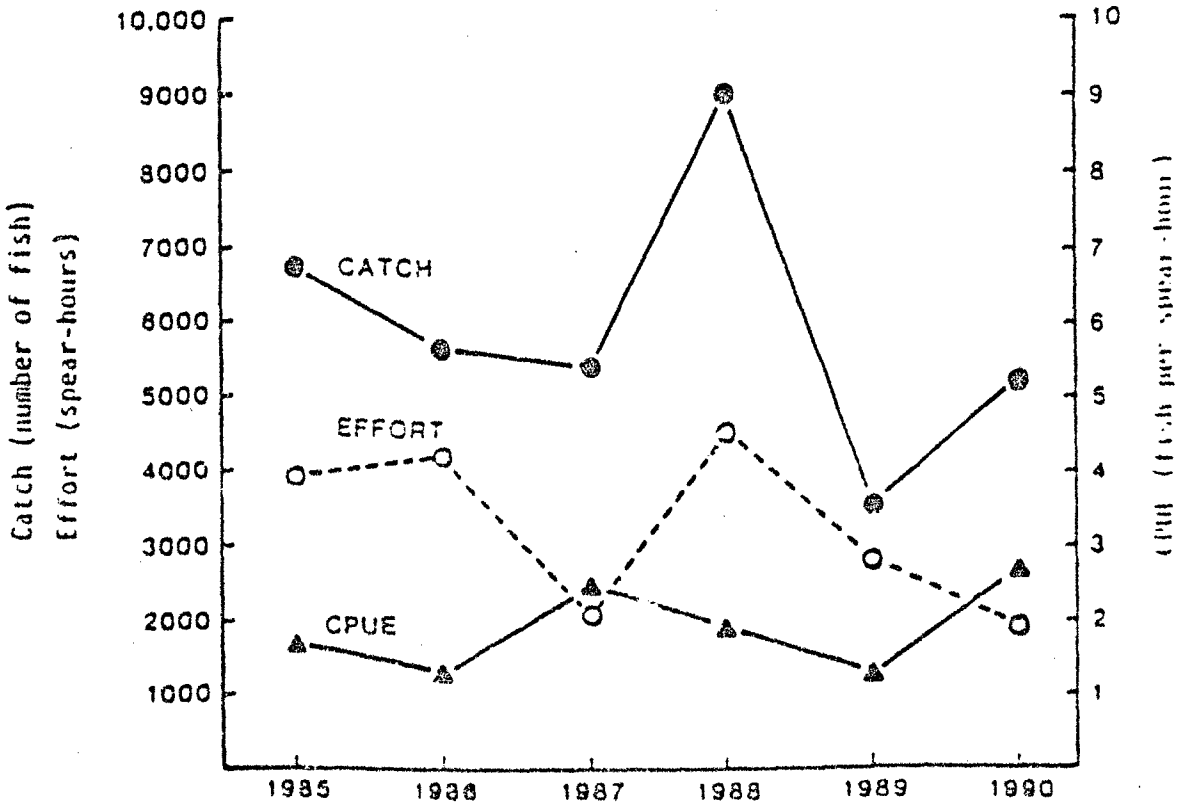


Figure 11. History of catch, effort and catch per unit effort (CPUE) of all species caught by spear fishing (using boats) over the full course of the study.

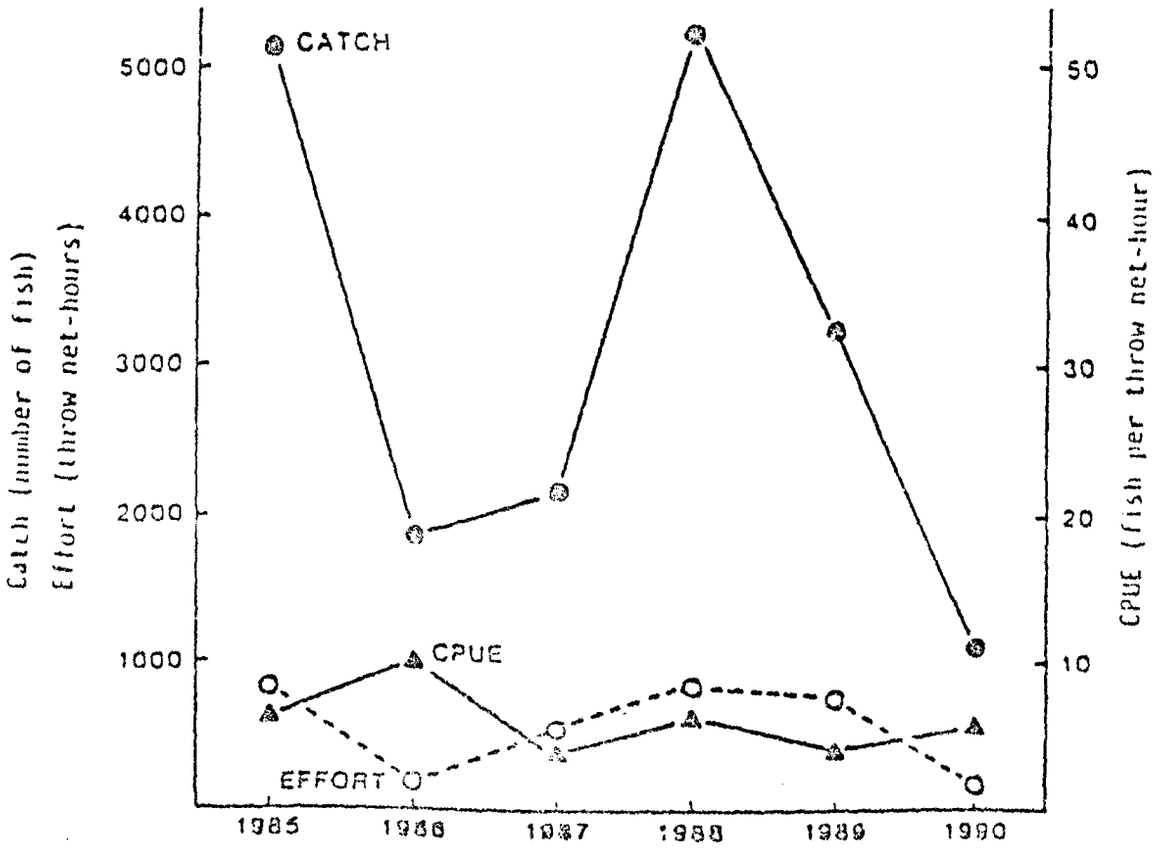


Figure 12. History of catch, effort and catch per unit effort (CPUE) of all species caught by throw net fishing (using boats) over the full course of the study.

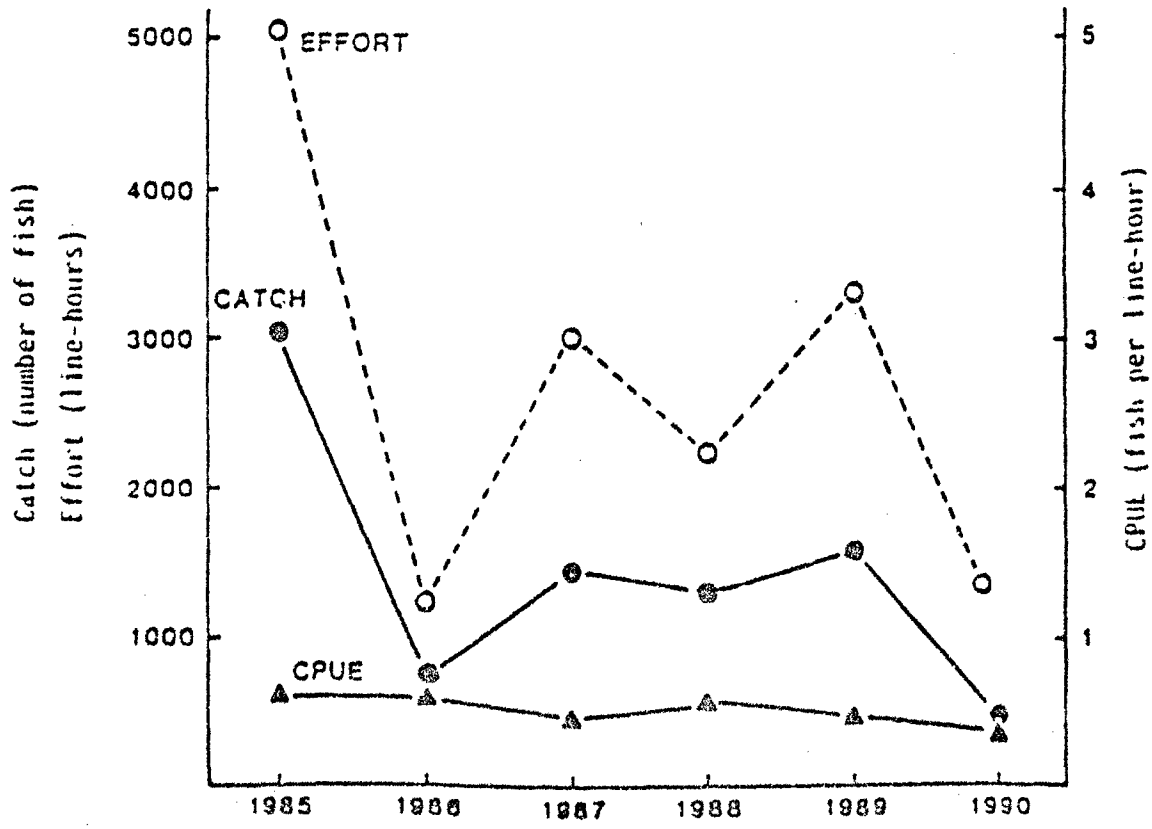


Figure 13. History of catch, effort and catch per unit effort (CPUE) of all species caught by line fishing (using boats) over the full course of the study.

Table 7. Boat catch and effort data for six successive phases of the project for the "major catch species". Resu
include the total estimated annual catch, and for the major gear type, the total effort and the catch per unit ef

Species	Estimated Annual Boat Catch (all gear combined), for year ending: 1990	1989	1988	1987	1986	'9
Myripristis amaenus	3362	1799	4474	4206	2029	30
Priacanthus cruentatus	79	49	63	94	95	1
Kuhlia marginata	225	240	555	75	293	14
Kyphosus vaigiensis	0	19	78	28	48	
Mulloides flavolineatus	128	903	396	269	266	3
Pseudocheilinus bifasciatus	64	144	370	207	358	3
Pseudocheilinus cyclostomus	129	435	322	282	239	5
Pseudocheilinus multifasciatus	38	338	289	288	198	-
Caranx melampygus	186	310	405	362	552	5
Chaerodon fasciatus leucisca	509	1201	3772	769	557	8
Scarus perspicillatus	83	315	353	185	289	1
Acanthurus triostegus	828	1657	2940	1222	1162	24
Ctenochaetus strigosus	1201	936	1609	1066	2188	31
Total	6,832	8,396	15,652	9,051	8,274	14,9

Effort and Catch per Unit Effort by major gear type for year ending:

Species	Major Gear Type	1990 Effort	1990 CPUE	1989 Effort	1989 CPUE	1988 Effort	1988 CPUE	1987 Effort	1987 CPUE	1986 Effort	1986 CPUE	'9 Effort
M. amaenus	spear	737	4.47	631	2.12	999	4.35	569	6.78	576	3.40	546
P. cruentatus	spear	194	0.41	74	0.60	404	0.13	198	0.38	276	0.27	526
K. marginata	net	30	6.23	46	4.97	33	16.03	63	1.28	30	9.93	134
K. vaigiensis	line	0	0	0	0	39	1.03	78	0.23	0	0	324
M. flavolineatus	net	21	3.05	166	4.44	60	3.92	59	4.14	27	6.23	63
P. bifasciatus	spear	131	0.46	269	0.28	505	0.63	117	0.62	556	0.57	448
P. cyclostomus	line	429	0.29	1227	0.28	766	0.39	492	0.55	362	0.63	1072
P. multifasciatus	line	226	0.16	737	0.38	743	0.38	348	0.63	207	0.62	890
C. melampygus	line	506	0.35	526	0.56	201	1.78	1063	0.32	472	0.61	1334
C. leucisca	net	81	6.28	251	4.28	353	10.69	268	2.87	51	10.47	245
S. perspicillatus	spear	143	0.51	624	0.50	591	0.58	343	0.54	618	0.47	370
A. triostegus	net	46	7.43	264	6.40	366	1.99	167	7.49	53	11.40	327
C. strigosus	spear	357	3.34	491	2.01	826	1.95	391	2.72	566	3.30	609

Fish Population Characteristics Based on Creel Census

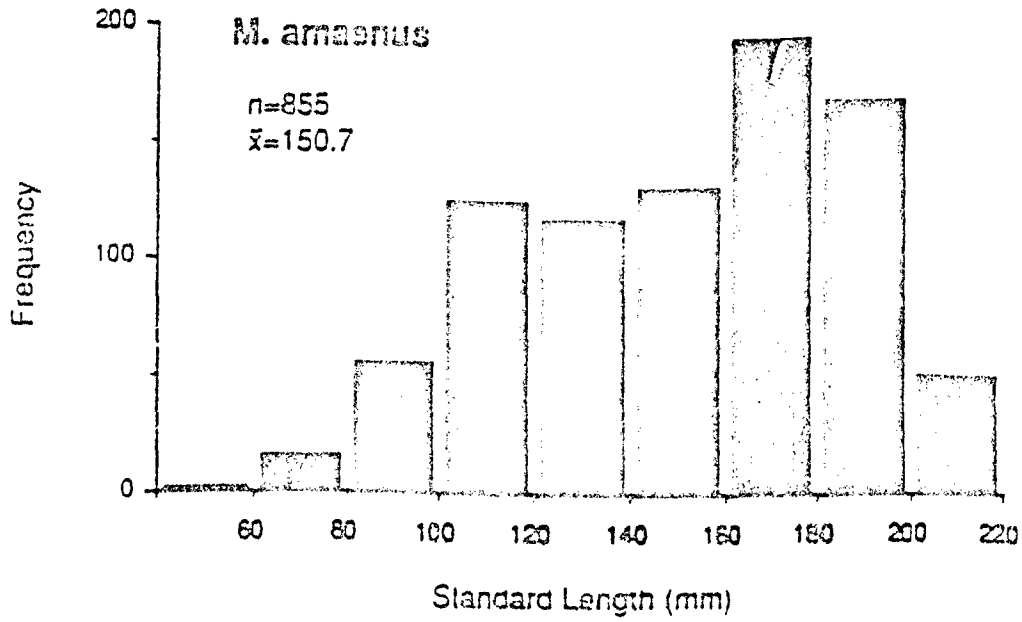
Some basic descriptive statistics for 11 of the "major catch species" were calculated from the creel census size data using SAS (version 5.16) on the University of Hawaii's mainframe IBM 3081 computer (Table 8). Only species with 70 or more specimens examined in creel census (from Feb 84 to May 90) were analyzed. Table 8 shows a summary of the data, as well as length-weight regression equations generated for each species, and the size at first reproduction for some of the species. Figures 14-24 are histograms of the standard lengths (SL) and weights of the individuals examined from Feb 84 to May 90. Appendix G contains frequency tables of SL and weights for the species shown in these histograms.

Most of the catch was of a fairly large size. The absence of very small individuals and the presence of several ascending size classes below the mode probably reflect selection for larger individuals by the gear and fishing techniques. However, very small individuals of any species were rarely seen in censuses or surveys. At body sizes above the mode, strong selection by fishermen for larger individuals of M. amaenus appears to produce a distribution that may be much different from the natural population at large (Fig. 14). For some species, the descending limb of the distribution curve (to the right of the mode) is rough (perhaps because of limited sample size). However, there seems to be no reason to believe that this portion of the distributions is far from representative of the natural populations in most cases. A cluster of large outliers of C. melampygus (Fig. 19) is produced by the efforts of a few fishermen specifically targetting large size classes.

Few cases of multiple modes appear clearly in any of the histograms. None of the data sets in their present condition appear promising for detecting cohorts for age or mortality estimation. No adequate data for size frequency are available from areas with low fishing effort for comparison with these data (which came primarily from the more heavily fished areas).

The sizes at first reproduction (SFR) for six of the 11 species shown in Table 8 were taken from the results of other investigators working in the Hawaiian Islands. No estimates were available for the SFR of Priacanthus cruentatus, Carangoides orthogrammus, Scarus perspicillatus, Ctenochaetus strigosus, and Chaenomugil leucosoma. No data were available from JA for the SFR of any species except Myripristis amaenus (Dee 1986), but it seems unlikely that any are greatly different from Hawaiian populations.

The number of fish caught and examined in creel census was inadequate to do many types of fishery analyses. The results presented here are thus somewhat limited, but they are adequate in light of the low level of catch. Since there has been no sustained and significant increase in fishing effort since the beginning of the project, all the basic descriptive data taken to date will serve as a useful baseline for comparison with samples taken after any future major changes in fishing effort. The frequency distributions of the catch species will be especially useful if fishing pressure significantly increases at JA.



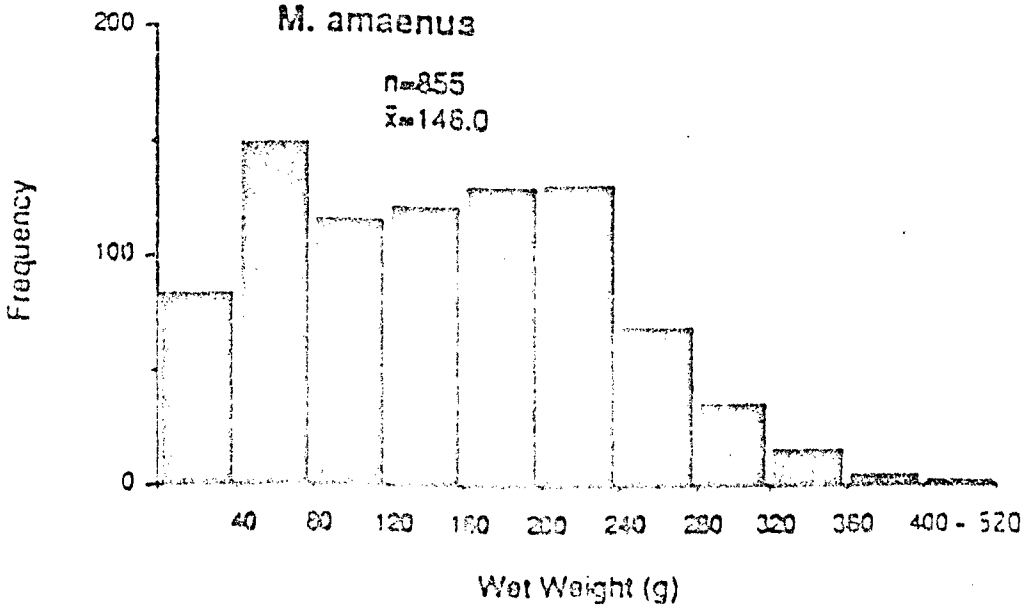
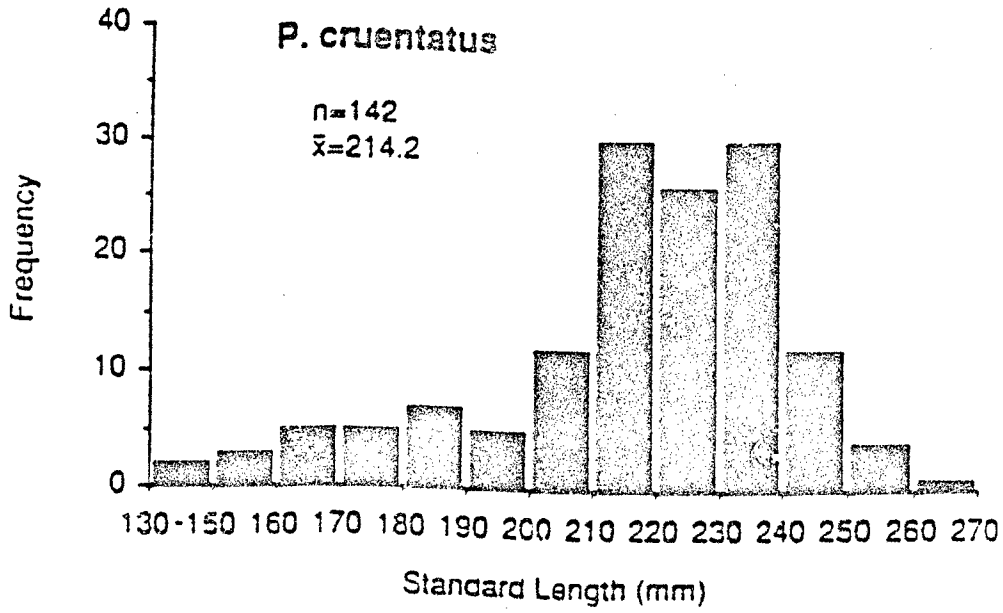


Fig. 14. Frequency histograms of standard lengths (mm) and wet weights (g) of M. amaenus creel censused between Feb 84 and May 90. The means ($\bar{x}$) represent the arithmetic average of all data taken during this period.



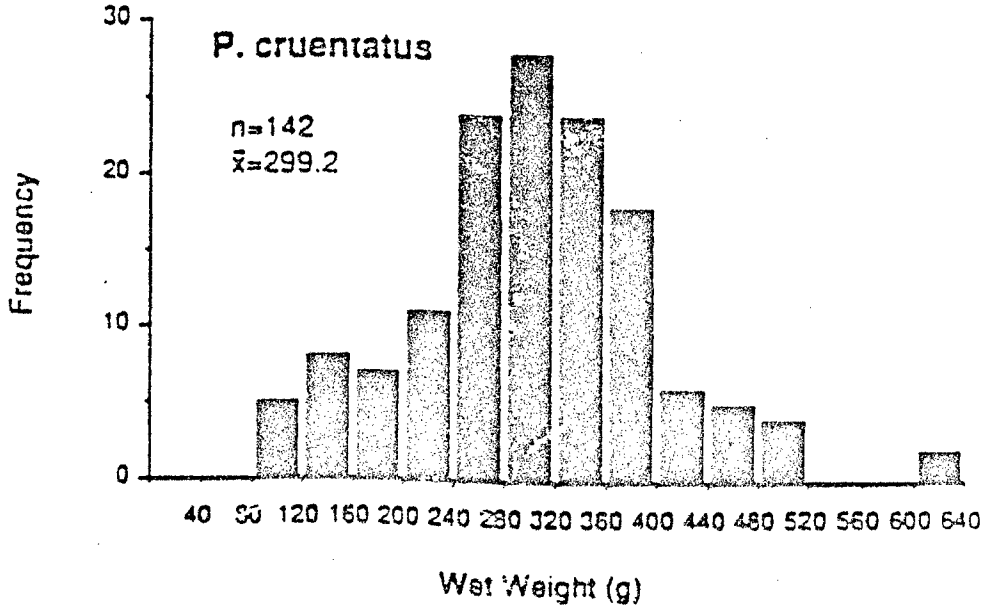
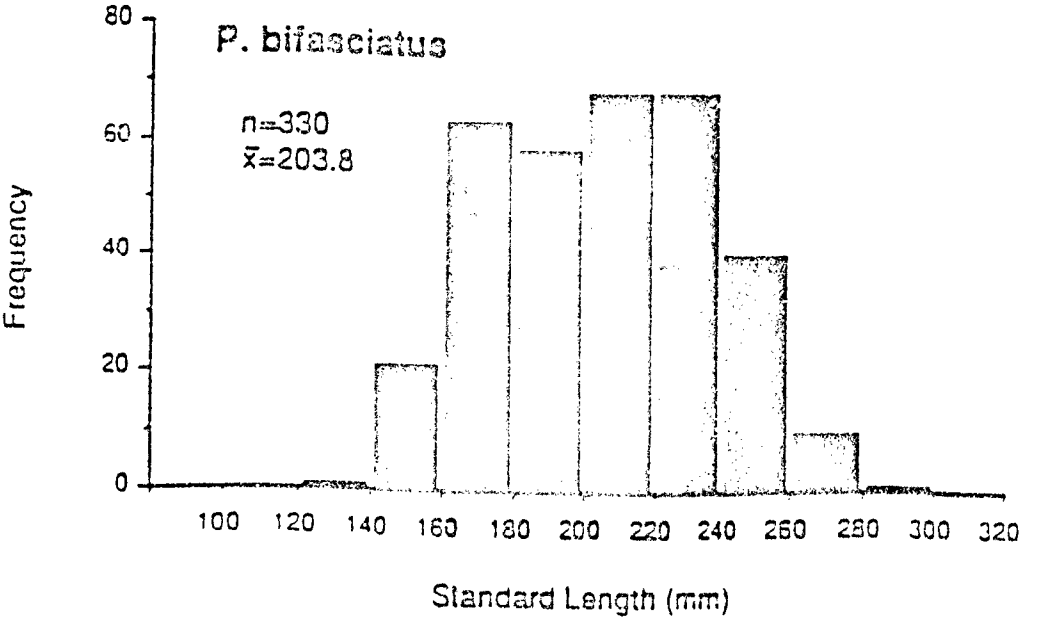


Fig. 15. Frequency histograms of standard lengths (mm) and wet weights (g) of P. cruentatus creel censused between Feb 84 and May 90. The means (x̄) represent the arithmetic average of all data taken during this period.



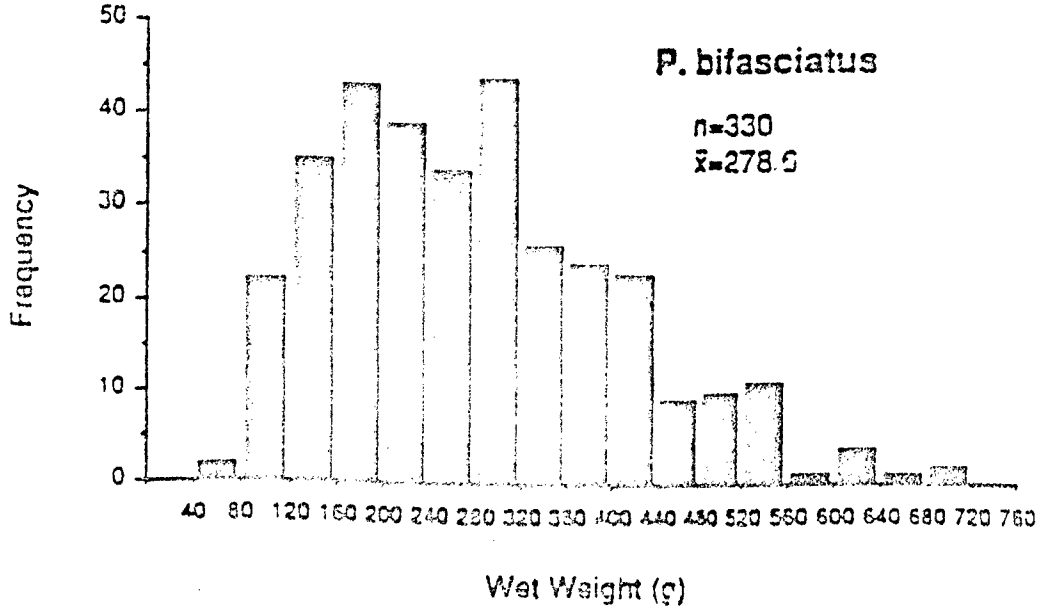
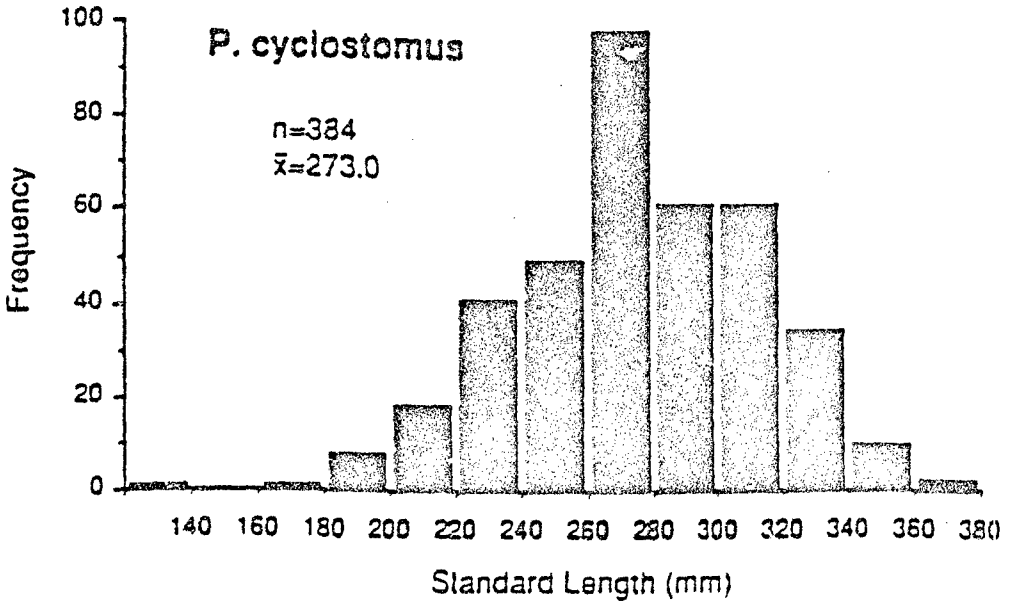


Fig. 16. Frequency histograms of standard lengths (mm) and wet weights (g) of P. bifasciatus creel censused between Feb 84 and May 90. The means ($\bar{x}$) represent the arithmetic average of all data taken during this period.



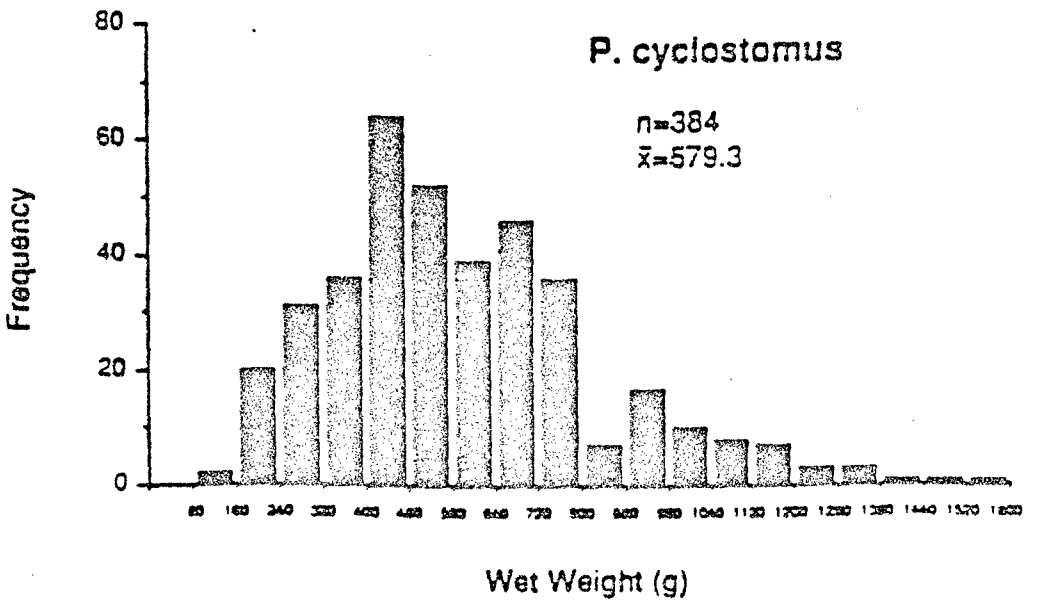
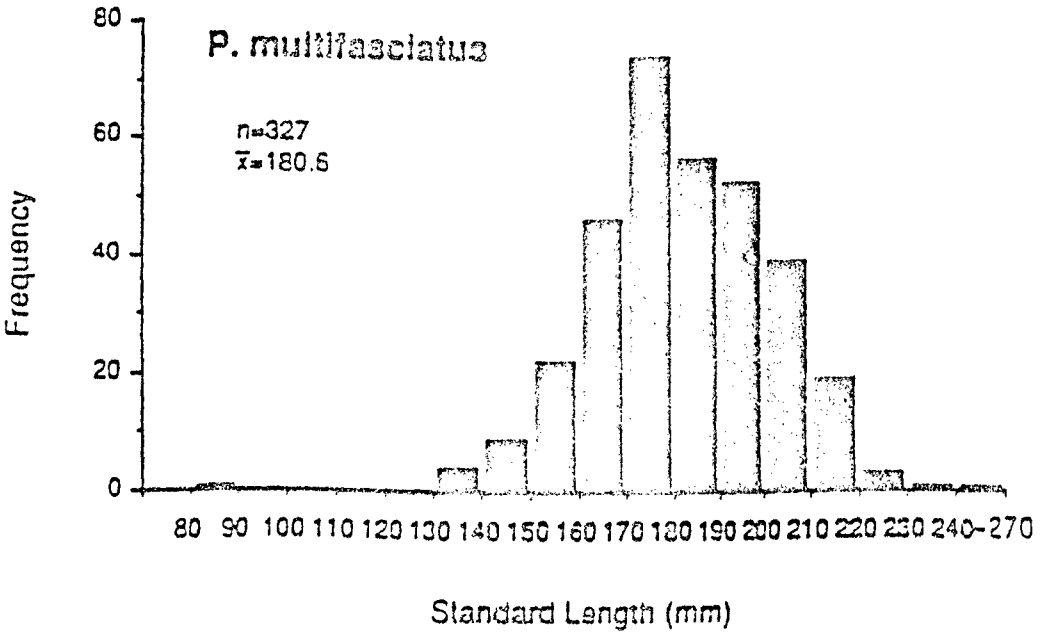


Fig. 17. Frequency histograms of standard lengths (mm) and wet weights (g) of P. cyclostomus creel censused between Feb 84 and May 90. The means (x̄) represent the arithmetic average of all data taken during this period.



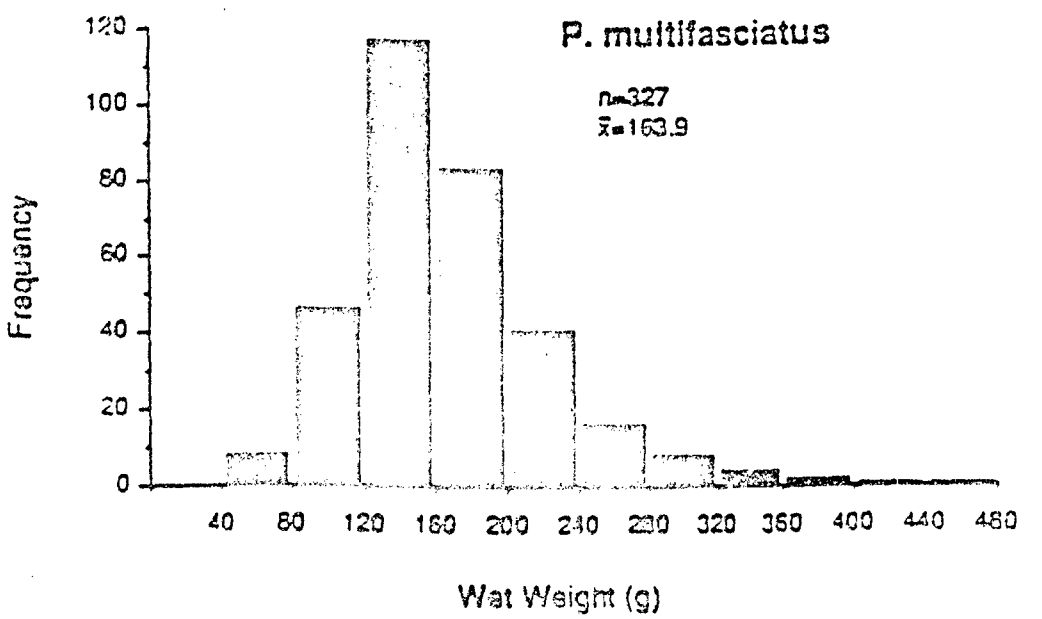
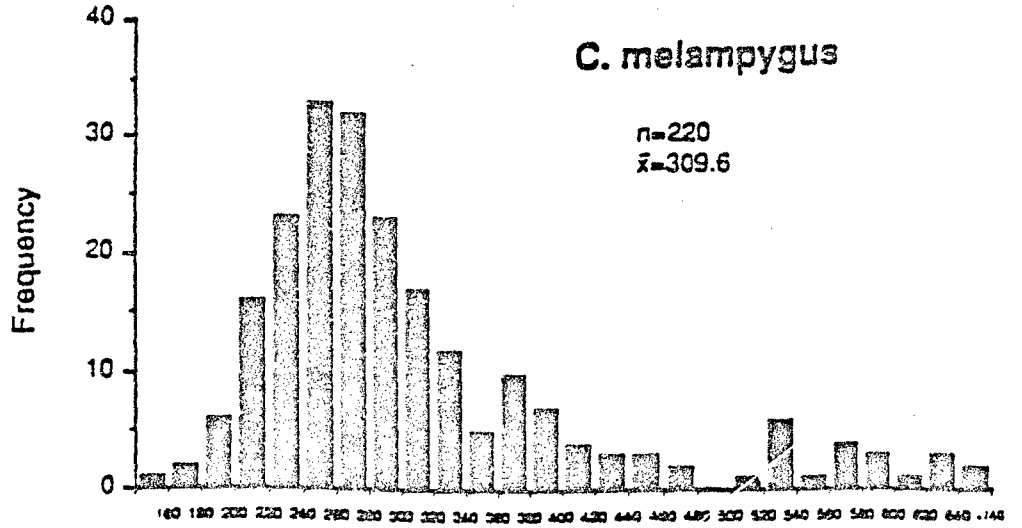


Fig. 18. Frequency histograms of standard lengths (mm) and wet weights (g) of P. multifasciatus creel censused between Feb 84 and May 90. The means ($\bar{x}$) represent the arithmetic average of all data taken during this period.



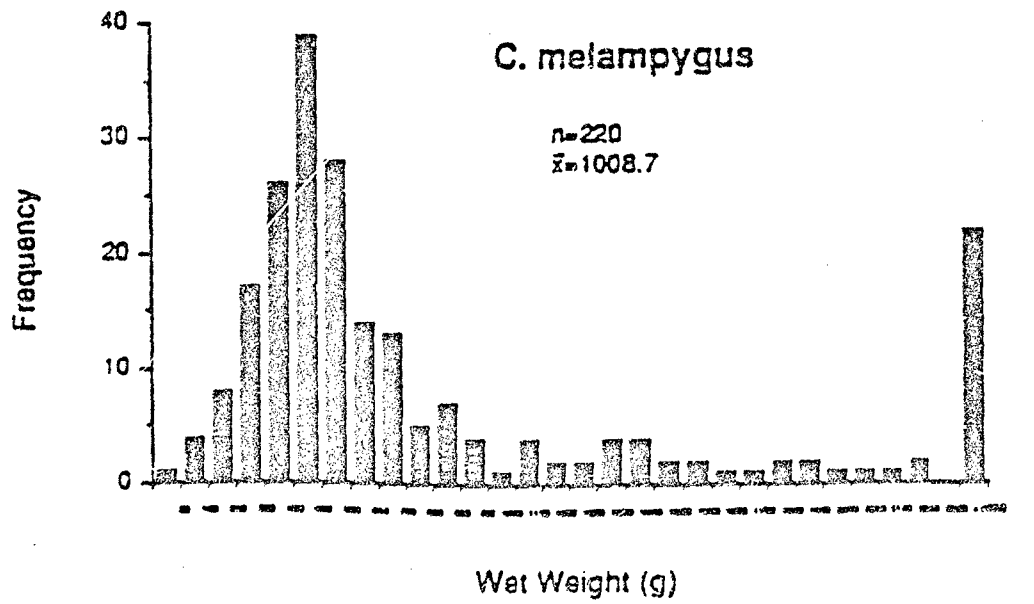
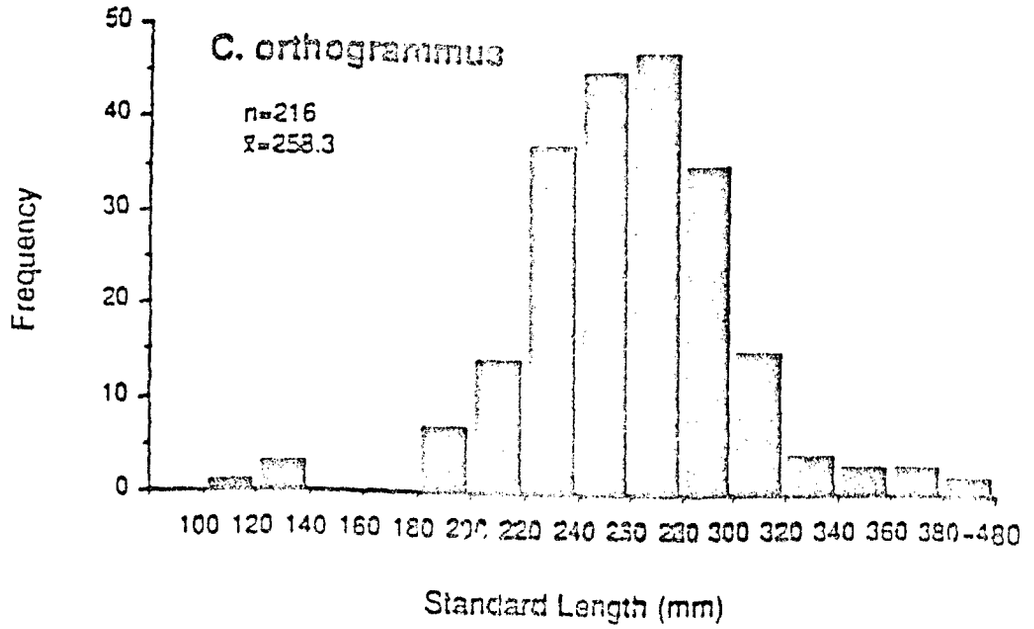


Fig. 19. Frequency histograms of standard lengths (mm) and wet weights (g) of C. melampygus creel censused between Feb 84 and May 90. The means ($\bar{x}$) represent the arithmetic average of all data taken during this period.



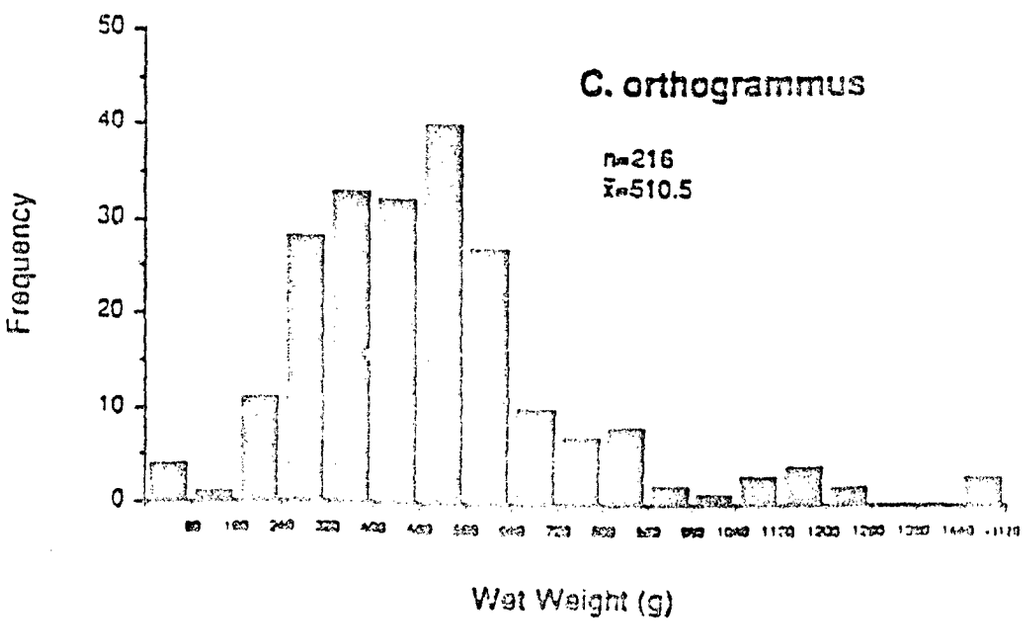
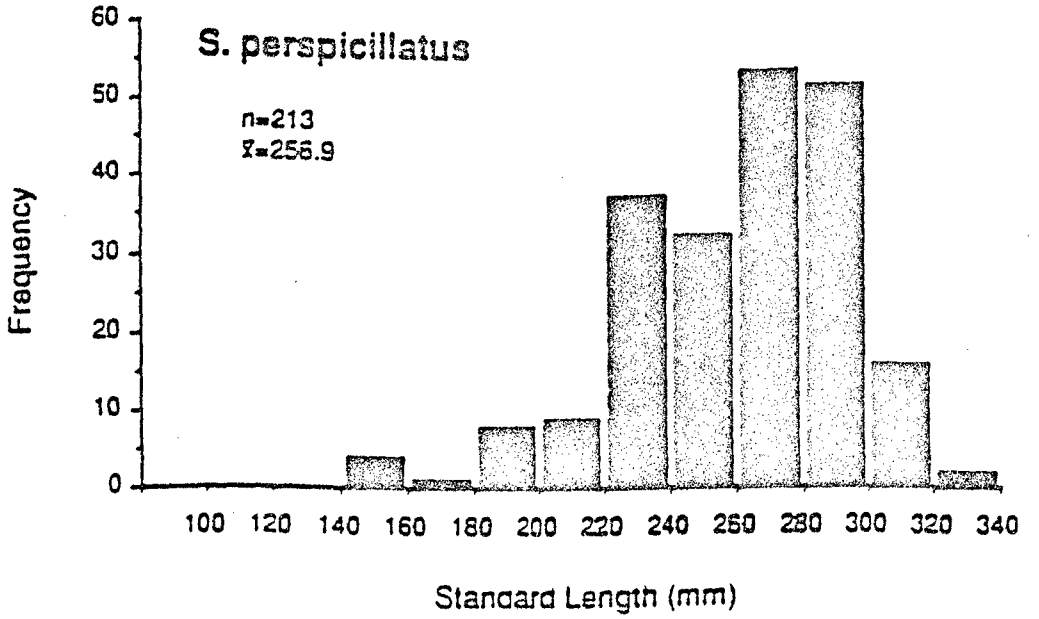


Fig. 20. Frequency histograms of standard lengths (mm) and wet weights (g) of C. orthogrammus creel censused between Feb 84 and May 90. The means ($\bar{x}$) represent the anthmetic average of all data taken during this period.



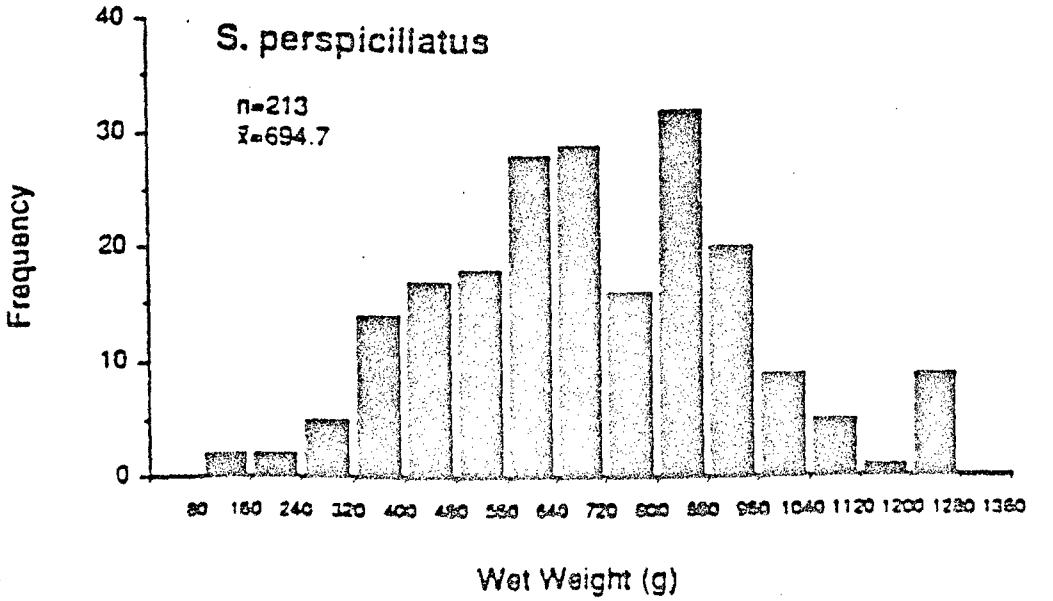


Fig. 21. Frequency histograms of standard lengths (mm) and wet weights (g) of S. perspicillatus creel censused between Feb 84 and May 90. The means ($\bar{x}$) represent th anthmetic average of all data taken dunng this period.

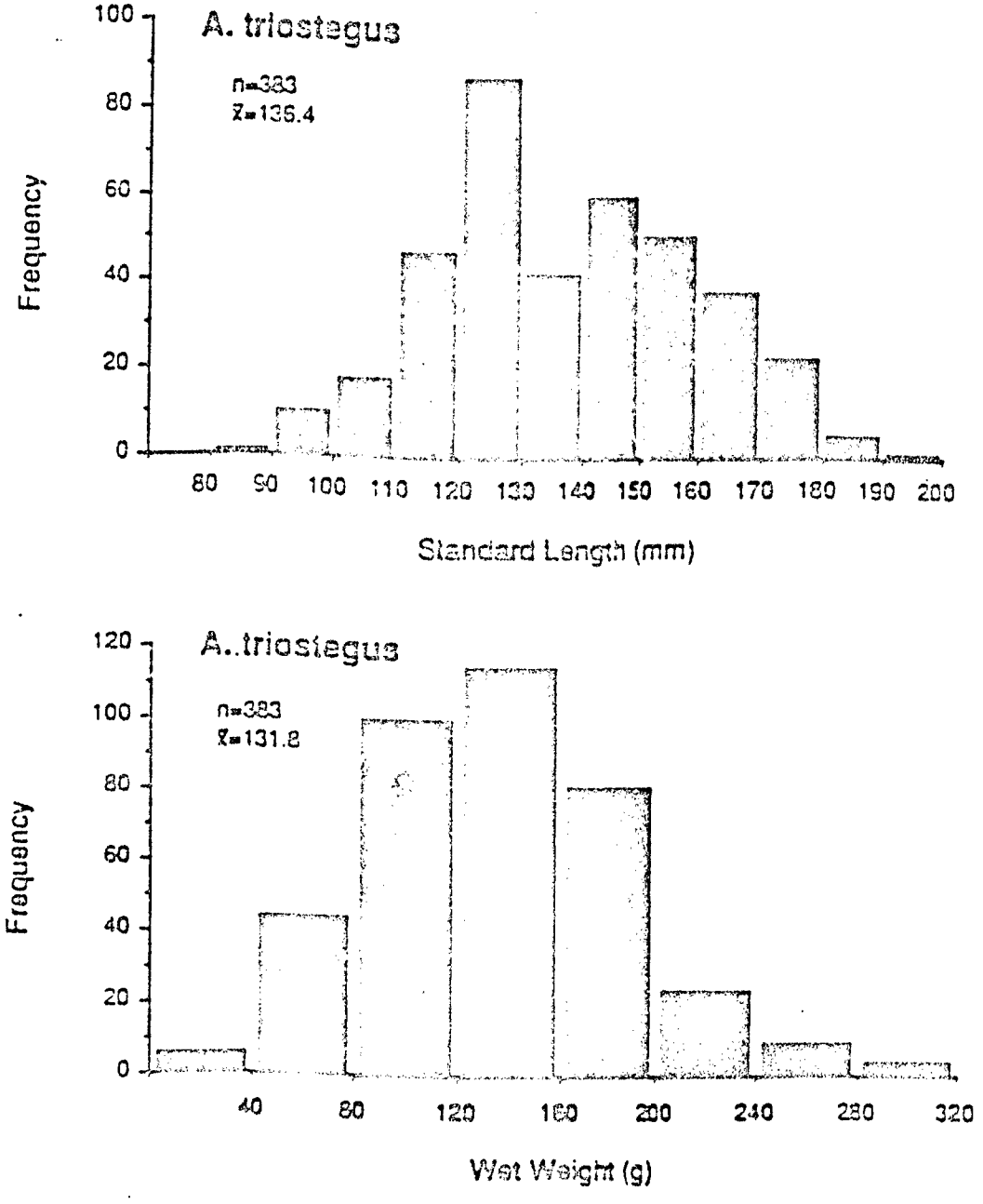
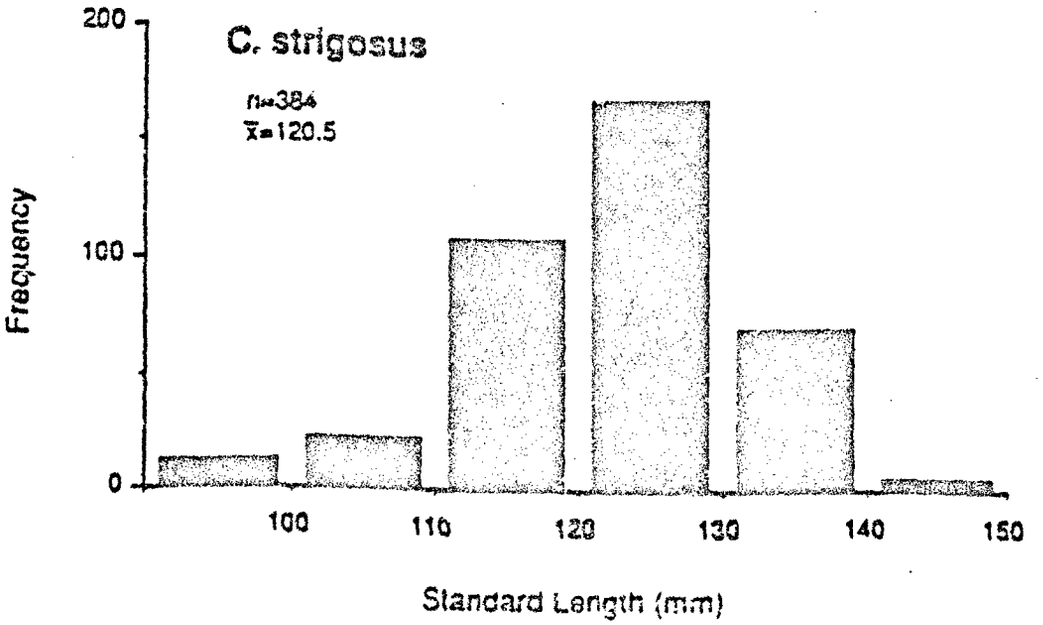


Fig. 22. Frequency histograms of standard lengths (mm) and wet weights (g) of A. triostegus creel censused between Feb 84 and May 90. The means ($\bar{x}$) represent the arithmetic average of all data taken during this period.



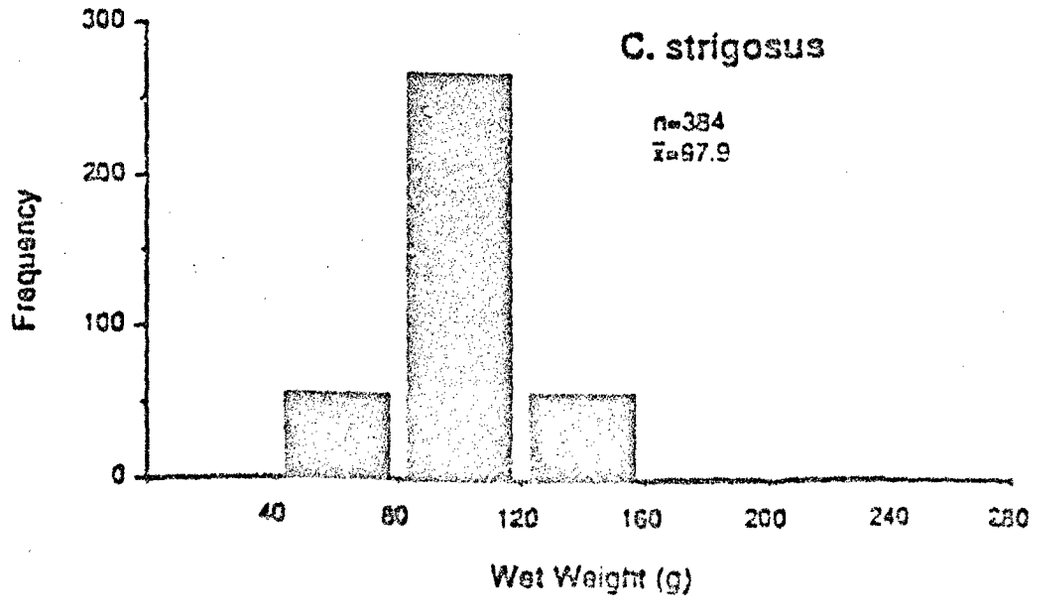
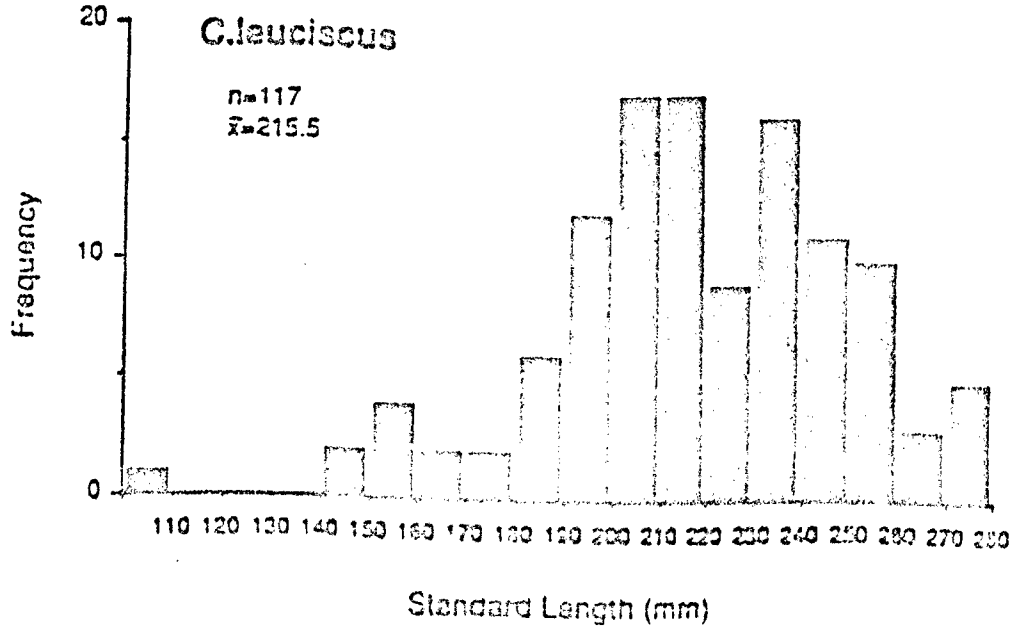


Fig. 23. Frequency histograms of standard lengths (mm) and wet weights (g) of C. strigosus creel censused between Feb 84 and May 90. The means ($\bar{x}$) represent the arithmetic average of all data taken during this period.



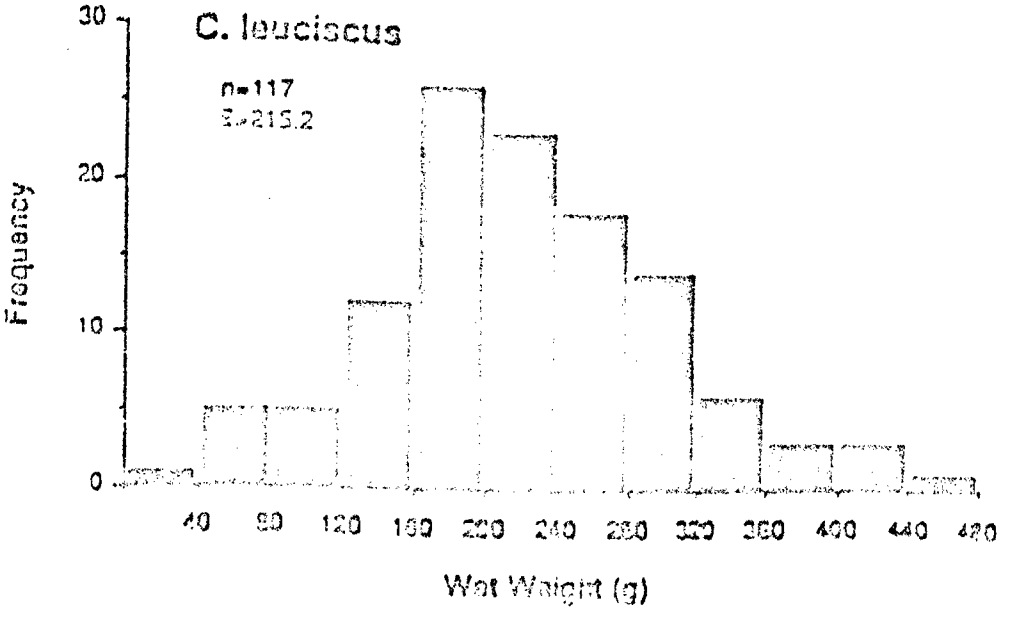


Fig. 24. Frequency histograms of standard lengths (mm) and wet weights (g) of C.leuciscus creel censused between Feb 84 and May 90. The means (x̄) represent the arithmetic average of all data taken during this period.

Table 8. Summary size data for 11 important catch species, based on creel census.

Catch species	Creel Census Data[1] Mean Standard Length, SL (mm)	Mean Weight, W (g)	Range of Weight (g)	Regression Equation $W = a(SL)^b$ a	b	r^2	n	Size at Fir Reproductio
Myripristis amoenus	150.7	146.0	2.8-480.0	7.00×10^{-5}	2.87	0.97	855	F 153-156 mm
								M 149-156 mm
Priacanthus cruentatus	214.2	299.2	80.0-600.0	5.41×10^{-5}	2.89	0.88	142	-
Pseudocheilinus bifasciatus	203.8	278.6	72.0-700.0	5.96×10^{-5}	2.88	0.86	330	~181 mm
Pseudocheilinus cyclostomus	273.1	579.2	130.0-1560.0	5.33×10^{-5}	2.88	0.82	384	~181 mm
Pseudocheilinus multifasciatus	180.6	163.9	40.0-440.0	1.35×10^{-4}	2.69	0.76	327	F < 115 mm
								M 164-200 mm
Caranx melampygus	309.6[2]	1008.7[2]	60.0-9000.0	7.35×10^{-5}	2.81	0.96	220	F 325-375 mm
Carangoides orthogrammus	258.3	510.5	30.0-3100.0	1.92×10^{-5}	3.06	0.91	216	-
Scarus perspicillatus	256.9	696.7	140.0-1265.0	1.07×10^{-3}	2.61	0.85	213	-
Acanthurus triostegus	136.4	131.8	20.0-310.0	5.51×10^{-4}	2.51	0.83	383	F 101 mm
								M 97 mm
Ctenochaetus strigosus	120.5	97.9	40.0-200.0	1.79×10^{-3}	2.27	0.63	384	-
Chaenomugil leucosus	215.5	215.3	20.0-470.0	2.93×10^{-5}	2.87	0.83	117	-

[1] Data only for species with 70 or more specimens examined from Feb 84 - May 90.

[2] There was one large outlier of SL = 736.6 mm and W = 9000.0 g that was excluded from the means.

[3] From Hayes et al. (1982) unless otherwise specified. (F = female, M = male).

[4] From Moffitt (1979) for Pseudocheilinus octotaenia.

[5] From Sudekum (1984).

[6] From Dee (1983).

ATOLL-WIDE ESTIMATES OF FISH POPULATIONS AND CATCHES

Rough atoll-wide population estimates for 10 of the 13 "major catch species" are presented in Table 9, column 1 (Dee et al. 1985). (For the remaining three "major catch species", data were insufficient to arrive at reasonable atoll-wide estimates.) Using these population estimates, the percent of the species population caught annually for the year ending 1990 was calculated and compared to that for the years ending 1989, 1988, 1987, 1986 and 1985 (Table 9, column 3).

Table 9. Estimated percents of species populations caught annually from boats for the years ending 1990 (Jun 89 - May 90), 1989 (Jun 88 - May 89), 1988 (Jun 87 - May 88), 1987 (Jun 86 - May 87), 1986 (Jun 85 - May 86), and 1985 (Feb 84 - May 85).

SPECIES	1 ESTIMATED ATOLL POPULATION	2 ESTIMATED TOTAL 1990 BOAT CATCH	3 ANNUAL CATCH/POPULATION (%) 1990	1989	1988	1987	1986	1985
Ctenochaetus striosus	1,650,300	1201	<0.1	<0.1	<0.1	<0.1	0.1	0.2
Acanthurus triostegus	599,600	823	0.1	0.3	0.5	0.2	0.2	0.4
Myripristis amaenus	383,400*	3362	0.9*	0.5*	1.2*	1.0*	0.5*	0.8*
Kuhlioides flavolineatus	128,900	123	<0.1	0.5	0.2	0.1	0.1	0.2
Pseudocheneus multifasciatus	61,650	35	<0.1	0.5	0.5	0.5	0.3	1.3
Pseudocheneus bifasciatus	43,000	66	0.1	0.3	0.8	0.4	0.7	0.8
Scarus perspicillatus	29,450	83	0.3	1.1	1.2	0.6	1.0	0.6
Pseudocheneus cyclostomus	27,600	129	0.5	1.6	1.2	1.0	0.9	2.0
Carenx melampygus	26,500	186	0.7	1.1	1.5	1.4	2.1	1.9
Kyphosus vaigiensis	22,350	0	0	0.1	0.3	0.1	0.2	0.2

* The atoll population estimate is probably a considerable underestimate because of its cryptic habits.

STATUS OF STOCKS

Harvested Species

The harvest assessment shows that few species were taken in sizable numbers and that the annual catches this past year, as in previous years, were insignificant compared to the estimated standing stocks of the respective species (Table 9).

More Myripristis amaenus are caught than any other species at JA. However, this catch estimate is quite small compared to the total population figure (Table 9, which is undoubtedly an underestimate for this cryptic species). In the year ending 1985, of the 193 measured specimens caught from shore by lines, approximately 93% were below the maximum SPR (Dee et al. 1985). No individuals caught by line fishing from shore were examined in the years ending 1986, 1988, 1989 and 1990. In the year ending 1987, of the 30 measured individuals caught from shore by lines, 90% were below the maximum SPR. Among measured specimens in the speared catch, about 22% of the individuals were below the maximum SPR in the years ending 1985 (n=233), 1986 (n=54), and 1987 (n=100); about 14% were below in 1988; about 25% in 1989, and none were below in 1990. This result is consistent with visual observations of individual size ranges at the long-term stations. Since the taking of individuals from the lagoon below the maximum SPR has apparently not increased much over the period of the study, the total atoll population should not be reduced by the present level of harvest.

There are no population size estimates for Kuhlia marginata or Chaenomugil leucosoma because of the nature of their habitat. These two species frequent the inland shorelines to feed. These areas are the only places where they are seen and caught. Under completely natural conditions, these species would probably make

similar use of shoreline habitat. No quantitative surveys or censuses were done in these habitats to provide population estimates. Net fishing for these species occurred less frequently this year than during the previous three years. In the absence of other data, little can be said about the status of these stocks except that the absolute catch values do not seem extremely high for an area of the general size of JA.

No information on SFR is available for Kyphosus vaigiensis, Mulloides flavolineatus, Scarus perspicillatus, or Ctenochaetus strigosus. All their catches are insignificant compared to their respective populations.

Based on the available Hawaiian values for SFR, our data suggest that approximately 30% of Pseudupeneus bifasciatus*, 1% of P. cyclostomus*, and 3% of Acanthurus triostegus are caught at sizes below their respective maximum SFR (based on data for all six years combined).

The total number of Pseudupeneus multifasciatus caught annually is not significant compared to the estimated standing stock (Table 9). Only one of the P. multifasciatus caught was below the SFR for females, but the male SFR falls in the range of sizes caught most frequently. Approximately 87% of the P. multifasciatus catch is below the maximum male SFR value.

About 82% of the Caranx melampygus catch is below the maximum SFR value. However, most of the individuals seen at the monitoring stations were much larger than the SFR. This seems to be due to the occasional presence of small schools of small individuals feeding near the piers of the islands where they are especially vulnerable to catch. The annual catch is very small compared to the standing stock.

When the 13 "major catch species" are considered as a group, the small size at capture of some species seems to offer some potential for concern if the catch levels were to increase greatly. In agreement with the results of the five previous phases, at present levels of effort, there appears to be very little impact on atoll fish populations as a result of fishing pressure.

The mandatory catch reporting system incorporated during the 1988 report year has resulted in higher reporting rates (compared with those of previous years) of invertebrates that previously went largely unreported. The catches of most species of coral and of total coral declined from last year, but comparisons with years prior to that would be misleading due to the substantial reduction in underreporting of boat catches that has resulted from the mandatory reporting system. However, the relatively small portion of the atoll accessible to coral collectors as well as the abundance of Acropora corals make it unlikely that the populations of these species will be threatened. A large majority of the coral populations (especially Distichopora sp., which is found primarily in the restricted area outside the barrier reef) lie outside the areas where recreational diving is permitted. In addition, the diurnally cryptic habits of most molluska popular with shell collectors are sufficient to prevent overcollection at the present low levels of fishing pressure. In

*Estimated from SFR for Pseudupeneus porphyreus.

spite of higher levels of reported catches compared with report years 1985-87, the major invertebrate catch species (coral, cephalopods, gastropods, crustaceans, and echinoderms) continue to be collected in insignificant numbers compared to their respective abundances.

Protected Species

Protected species occurring at JA are the threatened green sea turtle (Chelonia mydas) and the endangered Hawaiian monk seal (Monachus schauinslandi). Turtles are most often found in the vicinity of Zones 11 and 12. This is the area where their major food source, the algae (Caulerpa spp.), occurs in abundance. Turtles are also seen occasionally throughout the lagoon and channel areas. One turtle was censused in April 1986 at Station P5. Hawaiian monk seals have been seen occasionally by residents at various locations throughout JA over the past several years. In November 1984, nine male monk seals were brought to JA from Laysan Island. At last report, none of these monk seals appears to have remained at JA; the last reported sighting was in the summer of 1986. Most of the other monk seals have not been seen since shortly after their arrival.

DEEP SEA FISHING

Although the scope of this project and report focuses on the lagoon and shallow platform waters, a brief discussion of the fishery for pelagic species of the deep waters surrounding the atoll as a whole will complete the picture of atoll fisheries. Deep sea fishing at JA is done from several landing craft ~13 m long (known locally as "Mike boats"), operated by port control personnel. All deep sea fishing is for recreational purposes and is done on weekends only. One or two "Mike boats" with five to seven residents and/or transient personnel each, go out Saturday and Sunday (weather permitting) for three to four hours. Table 10 presents rough annual catch estimates for the fish species occurring in the deep sea catch during Jun 89 - May 90 (1990), Jun 88 - May 89 (1989), Jun 87 - May 88 (1988), Jun 86 - May 87 (1987), Jun 83 - May 86 (1986), and Feb 84 - May 85 (1985), based on catch reports and creel census. Little time and effort was spent collecting catch data for these trips. The data set is small, and no underreporting estimate was made for these deep sea catches. Although there is a broad decreasing trend in the estimated deep-sea catch over the period of Table 10, in the absence of effort data, little can be said about changes in the local abundance of these species. The deep sea catch at JA is essentially independent of the lagoon and its fishing activity. There is probably little or nothing that JA resource management can do that will affect these species significantly.

Table 10. Estimate of annual catch of deep sea species (uncorrected for underreporting).

SPECIES	ESTIMATED NO. CAUGHT					
	1990	1989	1988	1987	1986	1985
Acanthocybium solandri (wahoo)	136	149	180	175	201	201
Thunnus albacares (yellowfin tuna)	70	65	110	120	135	111
Sphyraena barracuda (great barracuda)	28	8	15	10	12	-
Katsuwonus pelamis (skipjack tuna)	23	29	60	50	90	134
Elagatis bipinnulatus (rainbow runner)	13	15	20	15	15	6
Coryphaena hippurus (dolphin)	5	6	10	6	8	5

SUMMARY

Environmental studies in the lagoon at Johnston Atoll continued through the project year in an attempt to detect any effects of JACADS activities (including any increase in recreational fishing) on the marine ecosystem. Established, long-term stations were monitored by visual, underwater censuses of fish and invertebrates. Catch and effort of the recreational fishery were monitored by use of catch reports completed by fishermen and by direct observation of fishing activity. Samples of the catch were examined to determine species and size composition.

Of the five stations censused, the three that appeared visually to provide similar habitat (Stations P1, P5, and P6) had similar fish communities, even though Station P5 was much more heavily fished than the physically very similar Station P6. Stations P3 and P7, which appeared visually different in habitat from each other and from the preceding stations, had distinctly different fish communities. Results of analyses by both similarity index and paired t-tests indicated these results. Similarity index analysis indicated relatively high levels of similarity within each station over the six years of the study, suggesting that activities related to JACADS development had not made a detectable change in these fish communities. The time series of population size as estimated by census was analyzed for temporal trends by two methods of correlation/regression. It seems likely that there has been a decreasing trend in the total number of fish and in the numbers of a good many species over the six years of the study. The changes do not seem associated with fishing, and there is no evidence to link them with any other human activity. It seems likely that this is a natural phenomenon, perhaps related to variability in recruitment. The available data on this apparently natural variability provide a valuable baseline for comparison with changes in fish populations that may occur in the future.

Fourteen fish species, octopus, and a few species of decorative coral made up the bulk of the recreational fishery. A

few decorative shelled mollusc species, lobsters, and occasional other invertebrates were also collected, as well as a few individuals of many other fish species. Comparing years was difficult because of variable underreporting of catch and effort. However, there seemed to be no evidence of significant or consistent increase in either total catch or effort over the six years of the study (despite a more than three-fold increase in JA human population at maximum). Most transient changes in catch seem to be explained by corresponding changes in effort. For all the major fish species caught, the total annual catch was small compared to the estimated size of the species population. Continued fishing at levels observed during the study is unlikely to affect the fish populations seriously. Increases reported in the 1989 catch of several invertebrates (e.g., corals, shelled molluscs, octopus) may reflect an artifact of reporting by fishermen. Catches of most of these species declined somewhat in the present year, but the trend will bear watching in future years.

The serious problem with compliance by boat fishermen with the catch reporting system during the year ending 1987 has largely been remedied. Mandatory catch reporting was incorporated into the sign-out/return procedure for recreational boat use in the year ending 1988, and the requirement for reporting all types of animals caught was stressed. Catch estimates for the past two years based on boat catch reports are believed to be reasonably accurate; the loss of data from previous years is irreparable and will continue to hamper analysis and interpretation of temporal trends. It is essential that compliance with reporting requirements for all catch be maintained high in order that the studies on the fishery can produce meaningful results. This issue must receive the necessary attention and continuing effective supervision by JA management if the project is to succeed.

During the project year, it became clear that compliance with reporting of shoreline catch and effort had deteriorated to the point that the data were not reliable for making the main quantitative estimates useful for management decisions. Compliance by fisherman cannot be enforced by project staff, and it is not feasible for project staff to collect the data directly. In response to our report of this status, JA administration indicated that they would not enforce compliance nor apply other means to secure shoreline catch and/or effort data. The attempt to use such data for quantitative analysis in the project has therefore been abandoned, and the effects of shoreline fishing on the fish stocks will remain unknown.

As of the end of the project year, the JACADS facility was just beginning operation, so monitoring of any environmental effects due to operation is still to come. A good baseline has been acquired, and no effects of construction have been detected. Lack of effects on the fishery may be due to a lack of increased fishing effort; it is not clear what the trend of human population and fishing effort will be in the future. However, if the effects of any future changes due to plant operation or fishing are to be detected, the study program presented here must be continued using much the same sampling methods and analyses.

Appendix B

TABLE B-1. Estimated 1-Hour Average Concentrations of Vapor-Phase TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site.

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
0.000	0.000	0.10869E-05
0.000	6.096	0.71606E-06
0.000	12.192	0.15821E-05
0.000	18.288	0.92511E-06
0.000	24.384	0.13211E-05
0.000	30.480	0.11776E-05
0.000	36.576	0.17014E-05
0.000	42.672	0.89331E-06
0.000	48.768	0.12986E-05
0.000	54.864	0.10935E-05
0.000	60.960	0.10394E-05
0.000	67.056	0.23507E-05
0.000	73.152	0.72389E-05
0.000	79.248	0.25512E-05
0.000	85.344	0.66881E-05
0.000	91.440	0.23620E-05
0.000	97.536	0.19368E-05
0.000	103.632	0.17130E-05
0.000	109.728	0.19697E-05
0.000	115.824	0.12683E-05
0.000	121.920	0.12411E-05
6.096	121.920	0.82771E-06
12.192	121.920	0.17928E-05
18.288	121.920	0.25317E-05
24.384	121.920	0.13754E-05
30.480	121.920	0.33187E-05
36.576	121.920	0.65311E-05
42.672	121.920	0.70387E-05
48.768	121.920	0.41036E-05
54.864	121.920	0.33110E-05
60.960	121.920	0.42264E-05
67.056	121.920	0.64511E-05
73.152	121.920	0.58688E-05
79.248	121.920	0.34911E-05
85.344	121.920	0.46393E-05
91.440	121.920	0.28861E-05
97.536	121.920	0.66784E-05

TABLE B-1. Estimated 1-Hour Average Concentrations of Vapor-Phase TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site. (Continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
103.632	121.920	0.27536E-05
109.728	121.920	0.67676E-05
115.824	121.920	0.27149E-05
121.920	121.920	0.54310E-05
128.016	121.920	0.22306E-05
134.112	121.920	0.52685E-05
140.208	121.920	0.20922E-05
146.304	121.920	0.47859E-05
152.400	121.920	0.16793E-05
158.496	121.920	0.40241E-05
164.592	121.920	0.23911E-05
170.688	121.920	0.73955E-05
176.784	121.920	0.26016E-05
182.880	121.920	0.77590E-05
188.976	121.920	0.27115E-05
195.072	121.920	0.10147E-05
195.072	115.824	0.29191E-05
195.072	109.728	0.84478E-05
195.072	103.632	0.32479E-05
195.072	97.536	0.81633E-05
195.072	91.440	0.27307E-05
195.072	85.344	0.51753E-05
195.072	79.248	0.21901E-05
195.072	73.152	0.52978E-05
195.072	67.056	0.18375E-05
195.072	60.960	0.10187E-05
188.976	60.960	0.20641E-05
182.880	60.960	0.48878E-05
176.784	60.960	0.17248E-05
170.688	60.960	0.45996E-05
164.592	60.960	0.37120E-05
158.496	60.960	0.93241E-05
152.400	60.960	0.36129E-05
146.304	60.960	0.93482E-05
146.304	54.864	0.33913E-05
146.304	48.768	0.34357E-05

TABLE B-1. Estimated 1-Hour Average Concentrations of Vapor-Phase TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site. (Continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
146.304	42.672	0.14158E-05
146.304	36.576	0.34726E-05
146.304	30.480	0.24876E-05
146.304	24.384	0.24098E-05
146.304	18.288	0.14316E-05
146.304	12.192	0.20872E-05
146.304	6.096	0.27877E-05
146.304	0.000	0.32758E-05
140.208	0.000	0.35537E-05
134.112	0.000	0.10083E-04
128.016	0.000	0.39054E-05
121.920	0.000	0.85703E-05
115.824	0.000	0.31626E-05
109.728	0.000	0.71679E-05
103.632	0.000	0.28354E-05
97.536	0.000	0.78186E-05
91.440	0.000	0.32782E-05
85.344	0.000	0.67743E-05
79.248	0.000	0.26083E-05
73.152	0.000	0.73547E-05
67.056	0.000	0.27275E-05
60.096	0.000	0.62408E-05
54.864	0.000	0.22823E-05
48.768	0.000	0.19447E-05
42.672	0.000	0.15307E-05
36.576	0.000	0.40823E-05
30.480	0.000	0.17803E-05
24.384	0.000	0.45009E-05
18.288	0.000	0.19206E-05
12.192	0.000	0.13845E-05
6.096	0.000	0.80730E-06

TABLE B-2. Estimated 1-Hour Average Concentrations of Vapor-Phase 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site.

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
0.000	0.000	0.19477E-02
0.000	6.096	0.39631E-02
0.000	12.192	0.26655E-02
0.000	18.288	0.97173E-02
0.000	24.384	0.70420E-02
0.000	30.480	0.25542E-01
0.000	36.576	0.67556E-01
0.000	42.672	0.26382E-01
0.000	48.768	0.67592E-01
0.000	54.864	0.25488E-01
0.000	60.960	0.69852E-02
0.000	67.056	0.96678E-02
0.000	73.152	0.26252E-02
0.000	79.248	0.46039E-02
0.000	85.344	0.19071E-02
0.000	91.440	0.55104E-02
0.000	97.536	0.33685E-02
0.000	103.632	0.40676E-02
0.000	109.728	0.60926E-02
0.000	115.824	0.21389E-02
0.000	121.920	0.61288E-02
6.096	121.920	0.60058E-02
12.192	121.920	0.49756E-02
18.288	121.920	0.30086E-02
24.384	121.920	0.67717E-02
30.480	121.920	0.25632E-01
36.576	121.920	0.18519E-01
42.672	121.920	0.67457E-01
48.768	121.920	0.18052E+00
54.864	121.920	0.67357E-01
60.960	121.920	0.17853E+00
67.056	121.920	0.67358E-01
73.152	121.920	0.18427E-01
79.248	121.920	0.25561E-01
85.344	121.920	0.66975E-02
91.440	121.920	0.29347E-02
97.536	121.920	0.49055E-02

TABLE B-2. Estimated 1-Hour Average Concentrations of Vapor-Phase 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site. (continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
103.632	121.920	0.59388E-02
109.728	121.920	0.60642E-02
115.824	121.920	0.56506E-02
121.920	121.920	0.50112E-02
128.016	121.920	0.43326E-02
134.112	121.920	0.37016E-02
140.208	121.920	0.31521E-02
146.304	121.920	0.26677E-02
152.400	121.920	0.23038E-02
158.496	121.920	0.40571E-02
164.592	121.920	0.20113E-02
170.688	121.920	0.24965E-02
176.784	121.920	0.13524E-02
182.880	121.920	0.16639E-02
188.976	121.920	0.19454E-02
195.072	121.920	0.19422E-02
195.072	115.824	0.15801E-02
195.072	109.728	0.15036E-02
195.072	103.632	0.19604E-02
195.072	97.536	0.21416E-02
195.072	91.440	0.17412E-02
195.072	85.344	0.13755E-02
195.072	79.248	0.14653E-02
195.072	73.152	0.25189E-02
195.072	67.056	0.13646E-02
195.072	60.960	0.14306E-02
188.976	60.960	0.12030E-02
182.880	60.960	0.14390E-02
176.784	60.960	0.20232E-02
170.688	60.960	0.18035E-02
164.592	60.960	0.22019E-02
158.496	60.960	0.33033E-02
152.400	60.960	0.47735E-02
146.304	60.960	0.58437E-02
146.304	54.864	0.21440E-02
146.304	48.768	0.63571E-02

TABLE B-2. Estimated 1-Hour Average Concentrations of Vapor-Phase 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site. (continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
146.304	42.672	0.14449E-02
146.304	36.576	0.63571E-02
146.304	30.480	0.17778E-02
146.304	24.384	0.58435E-02
146.304	18.288	0.12571E-02
146.304	12.192	0.50959E-02
146.304	6.096	0.18491E-02
146.304	0.000	0.26943E-02
140.208	0.000	0.52016E-02
134.112	0.000	0.29861E-02
128.016	0.000	0.19225E-02
121.920	0.000	0.86733E-02
115.824	0.000	0.20161E-02
109.728	0.000	0.90958E-02
103.632	0.000	0.28467E-02
97.536	0.000	0.93074E-02
91.440	0.000	0.12760E-01
85.344	0.000	0.62689E-02
79.248	0.000	0.32600E-02
73.152	0.000	0.62469E-02
67.056	0.000	0.11686E-01
60.096	0.000	0.91177E-02
54.864	0.000	0.28482E-02
48.768	0.000	0.90952E-02
42.672	0.000	0.22583E-02
36.576	0.000	0.86766E-02
30.480	0.000	0.19236E-02
24.384	0.000	0.30140E-02
18.288	0.000	0.52274E-02
12.192	0.000	0.27159E-02
6.096	0.000	0.17363E-02

TABLE E-3. Estimated 1-Hour Average Concentrations of Vapor-Phase 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site.

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
0.000	0.000	0.40998E-02
0.000	6.096	0.30514E-02
0.000	12.192	0.51275E-02
0.000	18.288	0.18139E-01
0.000	24.384	0.13190E-01
0.000	30.480	0.47583E-01
0.000	36.576	0.12670E+00
0.000	42.672	0.48208E-01
0.000	48.768	0.12590E+00
0.000	54.864	0.47446E-01
0.000	60.960	0.13036E-01
0.000	67.056	0.18007E-01
0.000	73.152	0.50186E-02
0.000	79.248	0.53689E-02
0.000	85.344	0.39782E-02
0.000	91.440	0.60774E-02
0.000	97.536	0.44624E-02
0.000	103.632	0.45234E-02
0.000	109.728	0.68376E-02
0.000	115.824	0.32081E-02
0.000	121.920	0.69038E-02
6.096	121.920	0.67646E-02
12.192	121.920	0.56497E-02
18.288	121.920	0.35287E-02
24.384	121.920	0.77137E-02
30.480	121.920	0.27982E-01
36.576	121.920	0.20313E-01
42.672	121.920	0.73438E-01
48.768	121.920	0.20046E+00
54.864	121.920	0.73290E-01
60.960	121.920	0.19416E+00
67.056	121.920	0.73231E-01
73.152	121.920	0.20133E-01
79.248	121.920	0.27832E-01
85.344	121.920	0.11522E-01
91.440	121.920	0.40237E-02
97.536	121.920	0.55060E-02

TABLE B-3. Estimated 1-Hour Average Concentrations of Vapor-Phase 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site. (continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
103.632	121.920	0.66277E-02
109.728	121.920	0.67720E-02
115.824	121.920	0.63372E-02
121.920	121.920	0.56586E-02
128.016	121.920	0.49383E-02
134.112	121.920	0.42681E-02
140.208	121.920	0.36863E-02
146.304	121.920	0.43281E-02
152.400	121.920	0.27947E-02
158.496	121.920	0.58916E-02
164.592	121.920	0.22107E-02
170.688	121.920	0.47877E-02
176.784	121.920	0.22674E-02
182.880	121.920	0.17181E-02
188.976	121.920	0.18273E-02
195.072	121.920	0.17304E-02
195.072	115.824	0.13019E-02
195.072	109.728	0.12953E-02
195.072	103.632	0.18293E-02
195.072	97.536	0.18026E-02
195.072	91.440	0.16046E-02
195.072	85.344	0.10864E-02
195.072	79.248	0.19185E-02
195.072	73.152	0.20209E-02
195.072	67.056	0.12299E-02
195.072	60.960	0.13806E-02
188.976	60.960	0.13524E-02
182.880	60.960	0.15511E-02
176.784	60.960	0.32245E-02
170.688	60.960	0.37882E-02
164.592	60.960	0.35080E-02
158.496	60.960	0.38885E-02
152.400	60.960	0.37995E-02
146.304	60.960	0.44871E-02
146.304	54.864	0.29576E-02
146.304	48.768	0.49692E-02

TABLE B-3. Estimated 1-Hour Average Concentrations of Vapor-Phase 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site. (continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
146.304	42.672	0.22117E-02
146.304	36.576	0.49690E-02
146.304	30.480	0.29834E-02
146.304	24.384	0.61789E-02
146.304	18.288	0.17737E-02
146.304	12.192	0.45863E-02
146.304	6.096	0.16218E-02
146.304	0.000	0.41072E-02
140.208	0.000	0.39609E-02
134.112	0.000	0.41424E-02
128.016	0.000	0.17067E-02
121.920	0.000	0.88917E-02
115.824	0.000	0.19144E-02
109.728	0.000	0.67356E-02
103.632	0.000	0.28113E-02
97.536	0.000	0.66454E-02
91.440	0.000	0.95679E-02
85.344	0.000	0.46037E-02
79.248	0.000	0.34387E-02
73.152	0.000	0.45487E-02
67.056	0.000	0.81558E-02
60.096	0.000	0.64398E-02
54.864	0.000	0.26765E-02
48.768	0.000	0.78736E-02
42.672	0.000	0.33379E-02
36.576	0.000	0.89007E-02
30.480	0.000	0.16248E-02
24.384	0.000	0.50808E-02
18.288	0.000	0.66992E-02
12.192	0.000	0.40998E-02
6.096	0.000	0.24769E-02

TABLE B-4. Estimated 8-Hour Average Concentrations of Vapor-Phase TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
0.000	0.000	0.76103E-06
0.000	6.096	0.50137E-06
0.000	12.192	0.11078E-05
0.000	18.288	0.64774E-06
0.000	24.384	0.92498E-06
0.000	30.480	0.82454E-06
0.000	36.576	0.11913E-05
0.000	42.672	0.62548E-06
0.000	48.768	0.90928E-06
0.000	54.864	0.76562E-06
0.000	60.960	0.72775E-06
0.000	67.056	0.16459E-05
0.000	73.152	0.50685E-05
0.000	79.248	0.17863E-05
0.000	85.344	0.46829E-05
0.000	91.440	0.16538E-05
0.000	97.536	0.13561E-05
0.000	103.632	0.11994E-05
0.000	109.728	0.13791E-05
0.000	115.824	0.88805E-06
0.000	121.920	0.86897E-06
6.096	121.920	0.57955E-06
12.192	121.920	0.12553E-05
18.288	121.920	0.17726E-05
24.384	121.920	0.96304E-06
30.480	121.920	0.23237E-05
36.576	121.920	0.45730E-05
42.672	121.920	0.49284E-05
48.768	121.920	0.28733E-05
54.864	121.920	0.23183E-05
60.960	121.920	0.29592E-05
67.056	121.920	0.45170E-05
73.152	121.920	0.41092E-05
79.248	121.920	0.24444E-05
85.344	121.920	0.32833E-05
91.440	121.920	0.20208E-05
97.536	121.920	0.46761E-05

TABLE B-4. Estimated 8-Hour Average Concentrations of Vapor-Phase TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
103.632	121.920	0.19280E-05
109.728	121.920	0.47386E-05
115.824	121.920	0.19009E-05
121.920	121.920	0.38027E-05
128.016	121.920	0.15618E-05
134.112	121.920	0.36889E-05
140.208	121.920	0.14649E-05
146.304	121.920	0.33510E-05
152.400	121.920	0.11758E-05
158.496	121.920	0.28176E-05
164.592	121.920	0.16742E-05
170.688	121.920	0.51782E-05
176.784	121.920	0.18216E-05
182.880	121.920	0.54327E-05
188.976	121.920	0.18986E-05
195.072	121.920	0.71046E-06
195.072	115.824	0.20439E-05
195.072	109.728	0.59150E-05
195.072	103.632	0.22741E-05
195.072	97.536	0.57158E-05
195.072	91.440	0.19120E-05
195.072	85.344	0.36236E-05
195.072	79.248	0.15334E-05
195.072	73.152	0.37094E-05
195.072	67.056	0.12366E-05
195.072	60.960	0.71327E-06
188.976	60.960	0.14452E-05
182.880	60.960	0.34224E-05
176.784	60.960	0.12077E-05
170.688	60.960	0.32206E-05
164.592	60.960	0.25990E-05
158.496	60.960	0.65285E-05
152.400	60.960	0.25297E-05
146.304	60.960	0.65454E-05
146.304	54.864	0.23745E-05
146.304	48.768	0.24056E-05

TABLE B-4. Estimated 8-Hour Average Concentrations of Vapor-Phase TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
146.304	42.672	0.99130E-06
146.304	36.576	0.24315E-05
146.304	30.480	0.17418E-05
146.304	24.384	0.16873E-05
146.304	18.288	0.10024E-05
146.304	12.192	0.14614E-05
146.304	6.096	0.19519E-05
146.304	0.000	0.22937E-05
140.208	0.000	0.24882E-05
134.112	0.000	0.70600E-05
128.016	0.000	0.27345E-05
121.920	0.000	0.60008E-05
115.824	0.000	0.22144E-05
109.728	0.000	0.50188E-05
103.632	0.000	0.19853E-05
97.536	0.000	0.54744E-05
91.440	0.000	0.22953E-05
85.344	0.000	0.47432E-05
79.248	0.000	0.18263E-05
73.152	0.000	0.51496E-05
67.056	0.000	0.19097E-05
60.096	0.000	0.43697E-05
54.864	0.000	0.15980E-05
48.768	0.000	0.13617E-05
42.672	0.000	0.10718E-05
36.576	0.000	0.28584E-05
30.480	0.000	0.12465E-05
24.384	0.000	0.31514E-05
18.288	0.000	0.13448E-05
12.192	0.000	0.96941E-06
6.096	0.000	0.56525E-06

TABLE B-5. Estimated 8-Hour Average Concentrations of Vapor-Phase 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site.

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
0.000	0.000	0.13637E-02
0.000	6.096	0.27748E-02
0.000	12.192	0.18663E-02
0.000	18.288	0.68037E-02
0.000	24.384	0.49306E-02
0.000	30.480	0.17884E-01
0.000	36.576	0.47511E-01
0.000	42.672	0.18472E-01
0.000	48.768	0.47326E-01
0.000	54.864	0.17846E-01
0.000	60.960	0.48908E-02
0.000	67.056	0.67691E-02
0.000	73.152	0.18381E-02
0.000	79.248	0.32235E-02
0.000	85.344	0.13353E-02
0.000	91.440	0.38582E-02
0.000	97.536	0.23585E-02
0.000	103.632	0.28480E-02
0.000	109.728	0.42659E-02
0.000	115.824	0.14976E-02
0.000	121.920	0.42912E-02
6.096	121.920	0.42051E-02
12.192	121.920	0.34838E-02
18.288	121.920	0.21065E-02
24.384	121.920	0.47413E-02
30.480	121.920	0.17947E-01
36.576	121.920	0.12966E-01
42.672	121.920	0.47231E-01
48.768	121.920	0.12640E+00
54.864	121.920	0.47161E-01
60.960	121.920	0.12500E+00
67.056	121.920	0.47162E-01
73.152	121.920	0.12902E-01
79.248	121.920	0.17897E-01
85.344	121.920	0.46894E-02
91.440	121.920	0.20548E-02
97.536	121.920	0.34347E-02

TABLE B-5. Estimated 8-Hour Average Concentrations of Vapor-Phase 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site. (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
103.632	121.920	0.41582E-02
109.728	121.920	0.42460E-02
115.824	121.920	0.39563E-02
121.920	121.920	0.35087E-02
128.016	121.920	0.30336E-02
134.112	121.920	0.25918E-02
140.208	121.920	0.22070E-02
146.304	121.920	0.18819E-02
152.400	121.920	0.16131E-02
158.496	121.920	0.28406E-02
164.592	121.920	0.14082E-02
170.688	121.920	0.17480E-02
176.784	121.920	0.94689E-03
182.880	121.920	0.11650E-02
188.976	121.920	0.13621E-02
195.072	121.920	0.13599E-02
195.072	115.824	0.11063E-02
195.072	109.728	0.10528E-02
195.072	103.632	0.13726E-02
195.072	97.536	0.14995E-02
195.072	91.440	0.12191E-02
195.072	85.344	0.96305E-03
195.072	79.248	0.10260E-02
195.072	73.152	0.17636E-02
195.072	67.056	0.95543E-03
195.072	60.960	0.10017E-02
188.976	60.960	0.84227E-03
182.880	60.960	0.10075E-02
176.784	60.960	0.14166E-02
170.688	60.960	0.12627E-02
164.592	60.960	0.15417E-02
158.496	60.960	0.23129E-02
152.400	60.960	0.33423E-02
146.304	60.960	0.40916E-02
146.304	54.864	0.15012E-02
146.304	48.768	0.44511E-02

TABLE B-5. Estimated 8-Hour Average Concentrations of Vapor-Phase 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site. (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
146.304	42.672	0.10117E-02
146.304	36.576	0.44510E-02
146.304	30.480	0.12448E-02
146.304	24.384	0.40915E-02
146.304	18.288	0.88019E-03
146.304	12.192	0.35680E-02
146.304	6.096	0.12946E-02
146.304	0.000	0.18865E-02
140.208	0.000	0.36420E-02
134.112	0.000	0.20908E-02
128.016	0.000	0.13461E-02
121.920	0.000	0.60728E-02
115.824	0.000	0.14116E-02
109.728	0.000	0.63686E-02
103.632	0.000	0.19931E-02
97.536	0.000	0.65167E-02
91.440	0.000	0.89339E-02
85.344	0.000	0.43893E-02
79.248	0.000	0.22826E-02
73.152	0.000	0.43739E-02
67.056	0.000	0.81820E-02
60.096	0.000	0.63839E-02
54.864	0.000	0.19942E-02
48.768	0.000	0.63682E-02
42.672	0.000	0.15812E-02
36.576	0.000	0.60751E-02
30.480	0.000	0.13468E-02
24.384	0.000	0.21103E-02
18.288	0.000	0.36601E-02
12.192	0.000	0.19016E-02
6.096	0.000	0.12157E-02

TABLE B-6. Estimated 8-Hour Average Concentrations of Vapor-Phase 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
0.000	0.000	0.28706E-02
0.000	6.096	0.21365E-02
0.000	12.192	0.35901E-02
0.000	18.288	0.12700E-01
0.000	24.384	0.92349E-02
0.000	30.480	0.33319E-01
0.000	36.576	0.88714E-01
0.000	42.672	0.33753E-01
0.000	48.768	0.88149E-01
0.000	54.864	0.33220E-01
0.000	60.960	0.91275E-02
0.000	67.056	0.12608E-01
0.000	73.152	0.35139E-02
0.000	79.248	0.37591E-02
0.000	85.344	0.27854E-02
0.000	91.440	0.42552E-02
0.000	97.536	0.31244E-02
0.000	103.632	0.31671E-02
0.000	109.728	0.47875E-02
0.000	115.824	0.23162E-02
0.000	121.920	0.48338E-02
6.096	121.920	0.47363E-02
12.192	121.920	0.39557E-02
18.288	121.920	0.24707E-02
24.384	121.920	0.54009E-02
30.480	121.920	0.19592E-01
36.576	121.920	0.14222E-01
42.672	121.920	0.51419E-01
48.768	121.920	0.14036E+00
54.864	121.920	0.51315E-01
60.960	121.920	0.13595E+00
67.056	121.920	0.51274E-01
73.152	121.920	0.14097E-01
79.248	121.920	0.19487E-01
85.344	121.920	0.80671E-02
91.440	121.920	0.28173E-02
97.536	121.920	0.38551E-02

TABLE B-6. Estimated 8-Hour Average Concentrations of Vapor-Phase 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
103.632	121.920	0.46405E-02
109.728	121.920	0.47415E-02
115.824	121.920	0.44371E-02
121.920	121.920	0.39620E-02
128.016	121.920	0.34576E-02
134.112	121.920	0.29884E-02
140.208	121.920	0.25810E-02
146.304	121.920	0.30304E-02
152.400	121.920	0.19568E-02
158.496	121.920	0.41251E-02
164.592	121.920	0.15478E-02
170.688	121.920	0.33522E-02
176.784	121.920	0.15876E-02
182.880	121.920	0.12029E-02
188.976	121.920	0.12794E-02
195.072	121.920	0.12116E-02
195.072	115.824	0.91155E-03
195.072	109.728	0.90693E-03
195.072	103.632	0.12808E-02
195.072	97.536	0.12621E-02
195.072	91.440	0.11235E-02
195.072	85.344	0.76067E-03
195.072	79.248	0.13433E-02
195.072	73.152	0.14150E-02
195.072	67.056	0.86112E-03
195.072	60.960	0.96662E-03
188.976	60.960	0.94691E-03
182.880	60.960	0.10860E-02
176.784	60.960	0.22577E-02
170.688	60.960	0.26523E-02
164.592	60.960	0.24562E-02
158.496	60.960	0.27226E-02
152.400	60.960	0.26603E-02
146.304	60.960	0.31417E-02
146.304	54.864	0.20708E-02
146.304	48.768	0.34792E-02

TABLE B-6. Estimated 8-Hour Average Concentrations of Vapor-Phase 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
146.304	42.672	0.15485E-02
146.304	36.576	0.34791E-02
146.304	30.480	0.20889E-02
146.304	24.384	0.43263E-02
146.304	18.288	0.12419E-02
146.304	12.192	0.32112E-02
146.304	6.096	0.11355E-02
146.304	0.000	0.28757E-02
140.208	0.000	0.27733E-02
134.112	0.000	0.29004E-02
128.016	0.000	0.11950E-02
121.920	0.000	0.62257E-02
115.824	0.000	0.13404E-02
109.728	0.000	0.47161E-02
103.632	0.000	0.19684E-02
97.536	0.000	0.46529E-02
91.440	0.000	0.66992E-02
85.344	0.000	0.32234E-02
79.248	0.000	0.24077E-02
73.152	0.000	0.31848E-02
67.056	0.000	0.57105E-02
60.096	0.000	0.45089E-02
54.864	0.000	0.18740E-02
48.768	0.000	0.55128E-02
42.672	0.000	0.23371E-02
36.576	0.000	0.62320E-02
30.480	0.000	0.11376E-02
24.384	0.000	0.35574E-02
18.288	0.000	0.46905E-02
12.192	0.000	0.28706E-02
6.096	0.000	0.17343E-02

TABLE B-7. Estimated Annual Average Concentrations of Vapor-Phase TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
0.000	0.000	0.27181E-07
0.000	6.096	0.17907E-07
0.000	12.192	0.39565E-07
0.000	18.288	0.23135E-07
0.000	24.384	0.33036E-07
0.000	30.480	0.29449E-07
0.000	36.576	0.42548E-07
0.000	42.672	0.22340E-07
0.000	48.768	0.32476E-07
0.000	54.864	0.27345E-07
0.000	60.960	0.25992E-07
0.000	67.056	0.58786E-07
0.000	73.152	0.18103E-06
0.000	79.248	0.63799E-07
0.000	85.344	0.16725E-06
0.000	91.440	0.59067E-07
0.000	97.536	0.48434E-07
0.000	103.632	0.42838E-07
0.000	109.728	0.49257E-07
0.000	115.824	0.31717E-07
0.000	121.920	0.31036E-07
6.096	121.920	0.20699E-07
12.192	121.920	0.44833E-07
18.288	121.920	0.63311E-07
24.384	121.920	0.34396E-07
30.480	121.920	0.82992E-07
36.576	121.920	0.16333E-06
42.672	121.920	0.17602E-06
48.768	121.920	0.10262E-06
54.864	121.920	0.82799E-07
60.960	121.920	0.10569E-06
67.056	121.920	0.16133E-06
73.152	121.920	0.14676E-06
79.248	121.920	0.87302E-07
85.344	121.920	0.11727E-06
91.440	121.920	0.72175E-07
97.536	121.920	0.16701E-06

TABLE B-7. Estimated Annual Average Concentrations of Vapor-Phase TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
103.632	121.920	0.68860E-07
109.728	121.920	0.16924E-06
115.824	121.920	0.67892E-07
121.920	121.920	0.13581E-06
128.016	121.920	0.55781E-07
134.112	121.920	0.13175E-06
140.208	121.920	0.52321E-07
146.304	121.920	0.11968E-06
152.400	121.920	0.41996E-07
158.496	121.920	0.10063E-06
164.592	121.920	0.59795E-07
170.688	121.920	0.18494E-06
176.784	121.920	0.65060E-07
182.880	121.920	0.19403E-06
188.976	121.920	0.67809E-07
195.072	121.920	0.25374E-07
195.072	115.824	0.72998E-07
195.072	109.728	0.21126E-06
195.072	103.632	0.81222E-07
195.072	97.536	0.20414E-06
195.072	91.440	0.68287E-07
195.072	85.344	0.12942E-06
195.072	79.248	0.54768E-07
195.072	73.152	0.13249E-06
195.072	67.056	0.45951E-07
195.072	60.960	0.25475E-07
188.976	60.960	0.51618E-07
182.880	60.960	0.12223E-06
176.784	60.960	0.43134E-07
170.688	60.960	0.11503E-06
164.592	60.960	0.92827E-07
158.496	60.960	0.23317E-06
152.400	60.960	0.90349E-07
146.304	60.960	0.23377E-06
146.304	54.864	0.84808E-07
146.304	48.768	0.85918E-07

TABLE B-7. Estimated Annual Average Concentrations of Vapor-Phase TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
146.304	42.672	0.35405E-07
146.304	36.576	0.86842E-07
146.304	30.480	0.62209E-07
146.304	24.384	0.60264E-07
146.304	18.288	0.35802E-07
146.304	12.192	0.52195E-07
146.304	6.096	0.69714E-07
146.304	0.000	0.81921E-07
140.208	0.000	0.88869E-07
134.112	0.000	0.25215E-06
128.016	0.000	0.97665E-07
121.920	0.000	0.21432E-06
115.824	0.000	0.79088E-07
109.728	0.000	0.17925E-06
103.632	0.000	0.70906E-07
97.536	0.000	0.19552E-06
91.440	0.000	0.81979E-07
85.344	0.000	0.16941E-06
79.248	0.000	0.65227E-07
73.152	0.000	0.18392E-06
67.056	0.000	0.68207E-07
60.096	0.000	0.15607E-06
54.864	0.000	0.57075E-07
48.768	0.000	0.48633E-07
42.672	0.000	0.38279E-07
36.576	0.000	0.10209E-06
30.480	0.000	0.44520E-07
24.384	0.000	0.11256E-06
18.288	0.000	0.48030E-07
12.192	0.000	0.34623E-07
6.096	0.000	0.20188E-07

TABLE B-8. Estimated Annual Average Concentrations of Vapor-Phase 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
0.000	0.000	0.48697E-04
0.000	6.096	0.99089E-04
0.000	12.192	0.66645E-04
0.000	18.288	0.24296E-03
0.000	24.384	0.17607E-03
0.000	30.480	0.63862E-03
0.000	36.576	0.16966E-02
0.000	42.672	0.65962E-03
0.000	48.768	0.16900E-02
0.000	54.864	0.63726E-03
0.000	60.960	0.17465E-03
0.000	67.056	0.24172E-03
0.000	73.152	0.65633E-04
0.000	79.248	0.11511E-03
0.000	85.344	0.47684E-04
0.000	91.440	0.13777E-03
0.000	97.536	0.84221E-04
0.000	103.632	0.10170E-03
0.000	109.728	0.15233E-03
0.000	115.824	0.53477E-04
0.000	121.920	0.15324E-03
6.096	121.920	0.15016E-03
12.192	121.920	0.12440E-03
18.288	121.920	0.75222E-04
24.384	121.920	0.16931E-03
30.480	121.920	0.64088E-03
36.576	121.920	0.46302E-03
42.672	121.920	0.16866E-02
48.768	121.920	0.45136E-02
54.864	121.920	0.16841E-02
60.960	121.920	0.44637E-02
67.056	121.920	0.16842E-02
73.152	121.920	0.46073E-03
79.248	121.920	0.63910E-03
85.344	121.920	0.16746E-03
91.440	121.920	0.73376E-04
97.536	121.920	0.12265E-03

TABLE B-8. Estimated Annual Average Concentrations of Vapor-Phase 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
103.632	121.920	0.14849E-03
109.728	121.920	0.15162E-03
115.824	121.920	0.14128E-03
121.920	121.920	0.12530E-03
128.016	121.920	0.10833E-03
134.112	121.920	0.92551E-04
140.208	121.920	0.78812E-04
146.304	121.920	0.67201E-04
152.400	121.920	0.57602E-04
158.496	121.920	0.10144E-03
164.592	121.920	0.50288E-04
170.688	121.920	0.62420E-04
176.784	121.920	0.33813E-04
182.880	121.920	0.41601E-04
188.976	121.920	0.48641E-04
195.072	121.920	0.48562E-04
195.072	115.824	0.39507E-04
195.072	109.728	0.37595E-04
195.072	103.632	0.49014E-04
195.072	97.536	0.53545E-04
195.072	91.440	0.43535E-04
195.072	85.344	0.34390E-04
195.072	79.248	0.36637E-04
195.072	73.152	0.62979E-04
195.072	67.056	0.34118E-04
195.072	60.960	0.35770E-04
188.976	60.960	0.30077E-04
182.880	60.960	0.35979E-04
176.784	60.960	0.50585E-04
170.688	60.960	0.45091E-04
164.592	60.960	0.55053E-04
158.496	60.960	0.82593E-04
152.400	60.960	0.11935E-03
146.304	60.960	0.14611E-03
146.304	54.864	0.53606E-04
146.304	48.768	0.15895E-03

TABLE B-8. Estimated Annual Average Concentrations of Vapor-Phase 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
146.304	42.672	0.36126E-04
146.304	36.576	0.15895E-03
146.304	30.480	0.44450E-04
146.304	24.384	0.14610E-03
146.304	18.288	0.31431E-04
146.304	12.192	0.12741E-03
146.304	6.096	0.46232E-04
146.304	0.000	0.67366E-04
140.208	0.000	0.13006E-03
134.112	0.000	0.74662E-04
128.016	0.000	0.48068E-04
121.920	0.000	0.21686E-03
115.824	0.000	0.50407E-04
109.728	0.000	0.22742E-03
103.632	0.000	0.71174E-04
97.536	0.000	0.23271E-03
91.440	0.000	0.31903E-03
85.344	0.000	0.15674E-03
79.248	0.000	0.81509E-04
73.152	0.000	0.15619E-03
67.056	0.000	0.29218E-03
60.096	0.000	0.22797E-03
54.864	0.000	0.71213E-04
48.768	0.000	0.22741E-03
42.672	0.000	0.56405E-04
36.576	0.000	0.21694E-03
30.480	0.000	0.48095E-04
24.384	0.000	0.75358E-04
18.288	0.000	0.13070E-03
12.192	0.000	0.67904E-04
6.096	0.000	0.43413E-04

TABLE B-9. Estimated Annual Average Concentrations of Vapor-Phase 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
0.000	0.000	0.10251E-03
0.000	6.096	0.76294E-04
0.000	12.192	0.12820E-03
0.000	18.288	0.45352E-03
0.000	24.384	0.32978E-03
0.000	30.480	0.11898E-02
0.000	36.576	0.31679E-02
0.000	42.672	0.12053E-02
0.000	48.768	0.31478E-02
0.000	54.864	0.11863E-02
0.000	60.960	0.32594E-03
0.000	67.056	0.45022E-03
0.000	73.152	0.12548E-03
0.000	79.248	0.13424E-03
0.000	85.344	0.99465E-04
0.000	91.440	0.15195E-03
0.000	97.536	0.11157E-03
0.000	103.632	0.11310E-03
0.000	109.728	0.17096E-03
0.000	115.824	0.82712E-04
0.000	121.920	0.17261E-03
6.096	121.920	0.16913E-03
12.192	121.920	0.14126E-03
18.288	121.920	0.88228E-04
24.384	121.920	0.19286E-03
30.480	121.920	0.69962E-03
36.576	121.920	0.50783E-03
42.672	121.920	0.18362E-02
48.768	121.920	0.50121E-02
54.864	121.920	0.18325E-02
60.960	121.920	0.48547E-02
67.056	121.920	0.18310E-02
73.152	121.920	0.50338E-03
79.248	121.920	0.69537E-03
85.344	121.920	0.28307E-03
91.440	121.920	0.10060E-03
97.536	121.920	0.13767E-03

TABLE B-9. Estimated Annual Average Concentrations of Vapor-Phase 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
103.632	121.920	0.16571E-03
109.728	121.920	0.16932E-03
115.824	121.920	0.15845E-03
121.920	121.920	0.14148E-03
128.016	121.920	0.12347E-03
134.112	121.920	0.10672E-03
140.208	121.920	0.92168E-04
146.304	121.920	0.10821E-03
152.400	121.920	0.69877E-04
158.496	121.920	0.14731E-03
164.592	121.920	0.55273E-04
170.688	121.920	0.11970E-03
176.784	121.920	0.56691E-04
182.880	121.920	0.42956E-04
188.976	121.920	0.45687E-04
195.072	121.920	0.43265E-04
195.072	115.824	0.32551E-04
195.072	109.728	0.32386E-04
195.072	103.632	0.45736E-04
195.072	97.536	0.45069E-04
195.072	91.440	0.40119E-04
195.072	85.344	0.27163E-04
195.072	79.248	0.47968E-04
195.072	73.152	0.50529E-04
195.072	67.056	0.30750E-04
195.072	60.960	0.34518E-04
188.976	60.960	0.33814E-04
182.880	60.960	0.38783E-04
176.784	60.960	0.80621E-04
170.688	60.960	0.94715E-04
164.592	60.960	0.87710E-04
158.496	60.960	0.97224E-04
152.400	60.960	0.94999E-04
146.304	60.960	0.11219E-03
146.304	54.864	0.73949E-04
146.304	48.768	0.12424E-03

TABLE B-9. Estimated Annual Average Concentrations of Vapor-Phase 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site (continued)

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
146.304	42.672	0.55298E-04
146.304	36.576	0.12424E-03
146.304	30.480	0.74594E-04
146.304	24.384	0.15449E-03
146.304	18.288	0.44348E-04
146.304	12.192	0.11467E-03
146.304	6.096	0.40550E-04
146.304	0.000	0.10269E-03
140.208	0.000	0.99033E-04
134.112	0.000	0.10357E-03
128.016	0.000	0.42672E-04
121.920	0.000	0.22232E-03
115.824	0.000	0.47864E-04
109.728	0.000	0.16841E-03
103.632	0.000	0.70291E-04
97.536	0.000	0.16615E-03
91.440	0.000	0.23923E-03
85.344	0.000	0.11511E-03
79.248	0.000	0.85978E-04
73.152	0.000	0.11373E-03
67.056	0.000	0.20392E-03
60.096	0.000	0.16101E-03
54.864	0.000	0.66920E-04
48.768	0.000	0.19686E-03
42.672	0.000	0.83456E-04
36.576	0.000	0.22254E-03
30.480	0.000	0.40624E-04
24.384	0.000	0.12703E-03
18.288	0.000	0.16750E-03
12.192	0.000	0.10251E-03
6.096	0.000	0.61930E-04

TABLE B-10. Estimated 1-Hour Average Concentrations of Particle-Associated TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
0.000	0.000	0.79800E-07
0.000	6.096	0.51560E-06
0.000	12.192	0.64930E-06
0.000	18.288	0.10700E-06
0.000	24.384	0.69100E-06
0.000	30.480	0.54920E-06
0.000	36.576	0.33510E-06
0.000	42.672	0.91270E-06
0.000	48.768	0.17620E-06
0.000	54.864	0.10329E-05
0.000	60.960	0.11560E-06
0.000	67.056	0.10329E-05
0.000	73.152	0.17630E-06
0.000	79.248	0.91270E-06
0.000	85.344	0.33530E-06
0.000	91.440	0.54920E-06
0.000	97.536	0.69120E-06
0.000	103.632	0.10700E-06
0.000	109.728	0.64920E-06
0.000	115.824	0.51560E-06
0.000	121.920	0.79800E-07
6.096	121.920	0.36670E-06
12.192	121.920	0.78420E-06
18.288	121.920	0.38060E-06
24.384	121.920	0.28400E-06
30.480	121.920	0.10137E-05
36.576	121.920	0.26380E-06
42.672	121.920	0.95500E-06
48.768	121.920	0.52050E-06
54.864	121.920	0.10385E-05
60.960	121.920	0.43080E-06
67.056	121.920	0.13628E-05
73.152	121.920	0.16800E-06
79.248	121.920	0.13630E-05
85.344	121.920	0.43080E-06
91.440	121.920	0.10389E-05
97.536	121.920	0.52050E-06

TABLE B-10. Estimated 1-Hour Average Concentrations of Particle-Associated TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
103.632	121.920	0.95530E-06
109.728	121.920	0.26360E-06
115.824	121.920	0.10137E-05
121.920	121.920	0.28420E-06
128.016	121.920	0.38040E-06
134.112	121.920	0.78420E-06
140.208	121.920	0.36680E-06
146.304	121.920	0.79800E-07
152.400	121.920	0.33040E-06
158.496	121.920	0.54250E-06
164.592	121.920	0.43790E-06
170.688	121.920	0.20460E-06
176.784	121.920	0.62800E-07
182.880	121.920	0.85300E-07
188.976	121.920	0.18310E-06
195.072	121.920	0.27900E-06
195.072	115.824	0.34480E-06
195.072	109.728	0.14160E-06
195.072	103.632	0.66800E-07
195.072	97.536	0.30220E-06
195.072	91.440	0.37230E-06
195.072	85.344	0.11370E-06
195.072	79.248	0.12900E-06
195.072	73.152	0.40520E-06
195.072	67.056	0.27770E-06
195.072	60.960	0.40000E-07
188.976	60.960	0.44500E-07
182.880	60.960	0.49900E-07
176.784	60.960	0.56200E-07
170.688	60.960	0.63700E-07
164.592	60.960	0.72900E-07
158.496	60.960	0.84000E-07
152.400	60.960	0.98000E-07
146.304	60.960	0.11550E-06
146.304	54.864	0.10330E-05
146.304	48.768	0.17620E-06

TABLE B-10. Estimated 1-Hour Average Concentrations of Particle-Associated TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
146.304	42.672	0.91280E-06
146.304	36.576	0.33520E-06
146.304	30.480	0.54940E-06
146.304	24.384	0.69110E-06
146.304	18.288	0.10700E-06
146.304	12.192	0.64930E-06
146.304	6.096	0.51550E-06
146.304	0.000	0.79800E-07
140.208	0.000	0.36680E-06
134.112	0.000	0.78420E-06
128.016	0.000	0.38040E-06
121.920	0.000	0.28420E-06
115.824	0.000	0.10137E-05
109.728	0.000	0.26360E-06
103.632	0.000	0.95520E-06
97.536	0.000	0.52030E-06
91.440	0.000	0.10387E-05
85.344	0.000	0.43060E-06
79.248	0.000	0.13629E-05
73.152	0.000	0.16810E-06
67.056	0.000	0.13629E-05
60.096	0.000	0.43090E-06
54.864	0.000	0.10387E-05
48.768	0.000	0.52060E-06
42.672	0.000	0.95520E-06
36.576	0.000	0.26360E-06
30.480	0.000	0.10137E-05
24.384	0.000	0.28410E-06
18.288	0.000	0.38040E-06
12.192	0.000	0.78420E-06
6.096	0.000	0.36680E-06

TABLE B-11. Estimated 1-Hour Average Concentrations of Particle-Associated 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
0.000	0.000	0.48800E-05
0.000	6.096	0.31510E-04
0.000	12.192	0.39680E-04
0.000	18.288	0.65400E-05
0.000	24.384	0.42230E-04
0.000	30.480	0.33560E-04
0.000	36.576	0.20480E-04
0.000	42.672	0.55780E-04
0.000	48.768	0.10770E-04
0.000	54.864	0.63120E-04
0.000	60.960	0.70600E-05
0.000	67.056	0.63120E-04
0.000	73.152	0.10770E-04
0.000	79.248	0.55780E-04
0.000	85.344	0.20490E-04
0.000	91.440	0.33560E-04
0.000	97.536	0.42240E-04
0.000	103.632	0.65400E-05
0.000	109.728	0.39680E-04
0.000	115.824	0.31510E-04
0.000	121.920	0.48800E-05
6.096	121.920	0.22410E-04
12.192	121.920	0.47920E-04
18.288	121.920	0.23260E-04
24.384	121.920	0.17360E-04
30.480	121.920	0.61950E-04
36.576	121.920	0.16120E-04
42.672	121.920	0.58360E-04
48.768	121.920	0.31810E-04
54.864	121.920	0.63460E-04
60.960	121.920	0.26330E-04
67.056	121.920	0.83280E-04
73.152	121.920	0.10260E-04
79.248	121.920	0.83300E-04
85.344	121.920	0.26330E-04
91.440	121.920	0.63490E-04
97.536	121.920	0.31810E-04

TABLE B-11. Estimated 1-Hour Average Concentrations of Particle-Associated 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
103.632	121.920	0.58380E-04
109.728	121.920	0.16110E-04
115.824	121.920	0.61950E-04
121.920	121.920	0.17370E-04
128.016	121.920	0.23250E-04
134.112	121.920	0.47920E-04
140.208	121.920	0.22420E-04
146.304	121.920	0.48800E-05
152.400	121.920	0.20190E-04
158.496	121.920	0.33160E-04
164.592	121.920	0.26760E-04
170.688	121.920	0.12510E-04
176.784	121.920	0.38400E-05
182.880	121.920	0.52100E-05
188.976	121.920	0.11190E-04
195.072	121.920	0.17050E-04
195.072	115.824	0.21070E-04
195.072	109.728	0.86500E-05
195.072	103.632	0.40800E-05
195.072	97.536	0.18470E-04
195.072	91.440	0.22750E-04
195.072	85.344	0.69500E-05
195.072	79.248	0.78800E-05
195.072	73.152	0.24760E-04
195.072	67.056	0.16970E-04
195.072	60.960	0.24500E-05
188.976	60.960	0.27200E-05
182.880	60.960	0.30500E-05
176.784	60.960	0.34300E-05
170.688	60.960	0.38900E-05
164.592	60.960	0.44500E-05
158.496	60.960	0.51400E-05
152.400	60.960	0.59900E-05
146.304	60.960	0.70600E-05
146.304	54.864	0.63130E-04
146.304	48.768	0.10770E-04

TABLE B-11. Estimated 1-Hour Average Concentrations of Particle-Associated 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	1-Hour Average Concentration (g/m^3)
146.304	42.672	0.55780E-04
146.304	36.576	0.20490E-04
146.304	30.480	0.33570E-04
146.304	24.384	0.42230E-04
146.304	18.288	0.65400E-05
146.304	12.192	0.39680E-04
146.304	6.096	0.31500E-04
146.304	0.000	0.48800E-05
140.208	0.000	0.22420E-04
134.112	0.000	0.47920E-04
128.016	0.000	0.23250E-04
121.920	0.000	0.17370E-04
115.824	0.000	0.61950E-04
109.728	0.000	0.16110E-04
103.632	0.000	0.58370E-04
97.536	0.000	0.31800E-04
91.440	0.000	0.63480E-04
85.344	0.000	0.26310E-04
79.248	0.000	0.83290E-04
73.152	0.000	0.10270E-04
67.056	0.000	0.83290E-04
60.096	0.000	0.26330E-04
54.864	0.000	0.63480E-04
48.768	0.000	0.31820E-04
42.672	0.000	0.58370E-04
36.576	0.000	0.16110E-04
30.480	0.000	0.61950E-04
24.384	0.000	0.17360E-04
18.288	0.000	0.23250E-04
12.192	0.000	0.47920E-04
6.096	0.000	0.22420E-04

TABLE B-12. Estimated 1-Hour Average Concentrations of Particle-Associated 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation

X Coordinate (m)	Y Coordinate (m)	1 Hour Average Concentration (g/m^3)
0.000	0.000	0.17290E-04
0.000	6.096	0.11171E-03
0.000	12.192	0.14069E-03
0.000	18.288	0.23180E-04
0.000	24.384	0.14972E-03
0.000	30.480	0.11900E-03
0.000	36.576	0.72610E-04
0.000	42.672	0.19775E-03
0.000	48.768	0.38170E-04
0.000	54.864	0.22380E-03
0.000	60.960	0.25040E-04
0.000	67.056	0.22380E-03
0.000	73.152	0.38200E-04
0.000	79.248	0.19775E-03
0.000	85.344	0.72660E-04
0.000	91.440	0.11900E-03
0.000	97.536	0.14976E-03
0.000	103.632	0.23180E-04
0.000	109.728	0.14067E-03
0.000	115.824	0.11171E-03
0.000	121.920	0.17300E-04
6.096	121.920	0.79450E-04
12.192	121.920	0.16991E-03
18.288	121.920	0.82450E-04
24.384	121.920	0.61540E-04
30.480	121.920	0.21963E-03
36.576	121.920	0.57150E-04
42.672	121.920	0.20692E-03
48.768	121.920	0.11278E-03
54.864	121.920	0.22501E-03
60.960	121.920	0.93340E-04
67.056	121.920	0.29528E-03
73.152	121.920	0.36390E-04
79.248	121.920	0.29532E-03
85.344	121.920	0.93340E-04
91.440	121.920	0.22510E-03
97.536	121.920	0.11278E-03

TABLE B-12. Estimated 1-Hour Average Concentrations of Particle-Associated 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
103.632	121.920	0.20698E-03
109.728	121.920	0.57110E-04
115.824	121.920	0.21963E-03
121.920	121.920	0.61570E-04
128.016	121.920	0.82420E-04
134.112	121.920	0.16991E-03
140.208	121.920	0.79480E-04
146.304	121.920	0.17290E-04
152.400	121.920	0.71590E-04
158.496	121.920	0.11755E-03
164.592	121.920	0.94880E-04
170.688	121.920	0.44340E-04
176.784	121.920	0.13610E-04
182.880	121.920	0.18480E-04
188.976	121.920	0.39660E-04
195.072	121.920	0.60440E-04
195.072	115.824	0.74710E-04
195.072	109.728	0.30680E-04
195.072	103.632	0.14470E-04
195.072	97.536	0.65480E-04
195.072	91.440	0.80670E-04
195.072	85.344	0.24640E-04
195.072	79.248	0.27940E-04
195.072	73.152	0.87790E-04
195.072	67.056	0.60170E-04
195.072	60.960	0.86700E-05
188.976	60.960	0.96500E-05
182.880	60.960	0.10810E-04
176.784	60.960	0.12170E-04
170.688	60.960	0.13810E-04
164.592	60.960	0.15730E-04
158.496	60.960	0.18210E-04
152.400	60.960	0.21230E-04
146.304	60.960	0.25030E-04
146.304	54.864	0.22381E-03
146.304	48.768	0.38180E-04

TABLE B-12. Estimated 1-Hour Average Concentrations of Particle-Associated 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	Annual Average Concentration (g/m^3)
146.304	42.672	0.19777E-03
146.304	36.576	0.72630E-04
146.304	30.480	0.11903E-03
146.304	24.384	0.14973E-03
146.304	18.288	0.23190E-04
146.304	12.192	0.14069E-03
146.304	6.096	0.11169E-03
146.304	0.000	0.17290E-04
140.208	0.000	0.79480E-04
134.112	0.000	0.16991E-03
128.016	0.000	0.82420E-04
121.920	0.000	0.61570E-04
115.824	0.000	0.21963E-03
109.728	0.000	0.57110E-04
103.632	0.000	0.20696E-03
97.536	0.000	0.11273E-03
91.440	0.000	0.22506E-03
85.344	0.000	0.93290E-04
79.248	0.000	0.29530E-03
73.152	0.000	0.36410E-04
67.056	0.000	0.29530E-03
60.096	0.000	0.93370E-04
54.864	0.000	0.22506E-03
48.768	0.000	0.11280E-03
42.672	0.000	0.20696E-03
36.576	0.000	0.57110E-04
30.480	0.000	0.21963E-03
24.384	0.000	0.61570E-04
18.288	0.000	0.82420E-04
12.192	0.000	0.16991E-03
6.096	0.000	0.79480E-04

TABLE B-13. Estimated 8-Hour Average Concentrations of Particle-Associated TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
0.000	0.000	0.55860E-07
0.000	6.096	0.36092E-06
0.000	12.192	0.45451E-06
0.000	18.288	0.74900E-07
0.000	24.384	0.48370E-06
0.000	30.480	0.38444E-06
0.000	36.576	0.23457E-06
0.000	42.672	0.63889E-06
0.000	48.768	0.12334E-06
0.000	54.864	0.72303E-06
0.000	60.960	0.80920E-07
0.000	67.056	0.72303E-06
0.000	73.152	0.12341E-06
0.000	79.248	0.63889E-06
0.000	85.344	0.23471E-06
0.000	91.440	0.38444E-06
0.000	97.536	0.48384E-06
0.000	103.632	0.74900E-07
0.000	109.728	0.45444E-06
0.000	115.824	0.36092E-06
0.000	121.920	0.55860E-07
6.096	121.920	0.25669E-06
12.192	121.920	0.54894E-06
18.288	121.920	0.26642E-06
24.384	121.920	0.19880E-06
30.480	121.920	0.70959E-06
36.576	121.920	0.18466E-06
42.672	121.920	0.66850E-06
48.768	121.920	0.36435E-06
54.864	121.920	0.72695E-06
60.960	121.920	0.30156E-06
67.056	121.920	0.95396E-06
73.152	121.920	0.11760E-06
79.248	121.920	0.95410E-06
85.344	121.920	0.30156E-06
91.440	121.920	0.72723E-06
97.536	121.920	0.36435E-06

TABLE B-13. Estimated 8-Hour Average Concentrations of Particle-Associated TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
103.632	121.920	0.66871E-06
109.728	121.920	0.18452E-06
115.824	121.920	0.70959E-06
121.920	121.920	0.19894E-06
128.016	121.920	0.26628E-06
134.112	121.920	0.54894E-06
140.208	121.920	0.25676E-06
146.304	121.920	0.55860E-07
152.400	121.920	0.23128E-06
158.496	121.920	0.37975E-06
164.592	121.920	0.30653E-06
170.688	121.920	0.14322E-06
176.784	121.920	0.43960E-07
182.880	121.920	0.59710E-07
188.976	121.920	0.12817E-06
195.072	121.920	0.19530E-06
195.072	115.824	0.24136E-06
195.072	109.728	0.99120E-07
195.072	103.632	0.46760E-07
195.072	97.536	0.21154E-06
195.072	91.440	0.26061E-06
195.072	85.344	0.79590E-07
195.072	79.248	0.90300E-07
195.072	73.152	0.28364E-06
195.072	67.056	0.19439E-06
195.072	60.960	0.28000E-07
188.976	60.960	0.31150E-07
182.880	60.960	0.34930E-07
176.784	60.960	0.39340E-07
170.688	60.960	0.44590E-07
164.592	60.960	0.51030E-07
158.496	60.960	0.58800E-07
152.400	60.960	0.68600E-07
146.304	60.960	0.80850E-07
146.304	54.864	0.72310E-06
146.304	48.768	0.12334E-06

TABLE B-13. Estimated 8-Hour Average Concentrations of Particle-Associated TCDD at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
146.304	42.672	0.63896E-06
146.304	36.576	0.23464E-06
146.304	30.480	0.38458E-06
146.304	24.384	0.48377E-06
146.304	18.288	0.74900E-07
146.304	12.192	0.45451E-06
146.304	6.096	0.36085E-06
146.304	0.000	0.55860E-07
140.208	0.000	0.25676E-06
134.112	0.000	0.54894E-06
128.016	0.000	0.26628E-06
121.920	0.000	0.19894E-06
115.824	0.000	0.70959E-06
109.728	0.000	0.18452E-06
103.632	0.000	0.66864E-06
97.536	0.000	0.36421E-06
91.440	0.000	0.72709E-06
85.344	0.000	0.30142E-06
79.248	0.000	0.95403E-06
73.152	0.000	0.11767E-06
67.056	0.000	0.95403E-06
60.096	0.000	0.30163E-06
54.864	0.000	0.72709E-06
48.768	0.000	0.36442E-06
42.672	0.000	0.66864E-06
36.576	0.000	0.18452E-06
30.480	0.000	0.70959E-06
24.384	0.000	0.19887E-06
18.288	0.000	0.26628E-06
12.192	0.000	0.54894E-06
6.096	0.000	0.25676E-06

TABLE B-14. Estimated 8-Hour Average Concentrations of Particle-Associated 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
0.000	0.000	0.34160E-05
0.000	6.096	0.22057E-04
0.000	12.192	0.27776E-04
0.000	18.288	0.45780E-05
0.000	24.384	0.29561E-04
0.000	30.480	0.23492E-04
0.000	36.576	0.14336E-04
0.000	42.672	0.39046E-04
0.000	48.768	0.75390E-05
0.000	54.864	0.44184E-04
0.000	60.960	0.49420E-05
0.000	67.056	0.44184E-04
0.000	73.152	0.75390E-05
0.000	79.248	0.39046E-04
0.000	85.344	0.14343E-04
0.000	91.440	0.23492E-04
0.000	97.536	0.29568E-04
0.000	103.632	0.45780E-05
0.000	109.728	0.27776E-04
0.000	115.824	0.22057E-04
0.000	121.920	0.34160E-05
6.096	121.920	0.15687E-04
12.192	121.920	0.33544E-04
18.288	121.920	0.16282E-04
24.384	121.920	0.12152E-04
30.480	121.920	0.43365E-04
36.576	121.920	0.11284E-04
42.672	121.920	0.40852E-04
48.768	121.920	0.22267E-04
54.864	121.920	0.44422E-04
60.960	121.920	0.18431E-04
67.056	121.920	0.58296E-04
73.152	121.920	0.71820E-05
79.248	121.920	0.58310E-04
85.344	121.920	0.18431E-04
91.440	121.920	0.44443E-04

TABLE B-14. Estimated 8-Hour Average Concentrations of Particle-Associated 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
97.536	121.920	0.22267E-04
103.632	121.920	0.40866E-04
109.728	121.920	0.11277E-04
115.824	121.920	0.43365E-04
121.920	121.920	0.12159E-04
128.016	121.920	0.16275E-04
134.112	121.920	0.33544E-04
140.208	121.920	0.15694E-04
146.304	121.920	0.34160E-05
152.400	121.920	0.14133E-04
158.496	121.920	0.23212E-04
164.592	121.920	0.18732E-04
170.688	121.920	0.87570E-05
176.784	121.920	0.26880E-05
182.880	121.920	0.36470E-05
188.976	121.920	0.78330E-05
195.072	121.920	0.11935E-04
195.072	115.824	0.14749E-04
195.072	109.728	0.60550E-05
195.072	103.632	0.28560E-05
195.072	97.536	0.12929E-04
195.072	91.440	0.15925E-04
195.072	85.344	0.48650E-05
195.072	79.248	0.55160E-05
195.072	73.152	0.17332E-04
195.072	67.056	0.11879E-04
195.072	60.960	0.17150E-05
188.976	60.960	0.19040E-05
182.880	60.960	0.21350E-05
176.784	60.960	0.24010E-05
170.688	60.960	0.27230E-05
164.592	60.960	0.31150E-05
158.496	60.960	0.35980E-05
152.400	60.960	0.41930E-05
146.304	60.960	0.49420E-05
146.304	54.864	0.44191E-04

TABLE B-14. Estimated 8-Hour Average Concentrations of Particle-Associated 2,4-D at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation (continued)

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
146.304	48.768	0.75390E-05
146.304	42.672	0.39046E-04
146.304	36.576	0.14343E-04
146.304	30.480	0.23499E-04
146.304	24.384	0.29561E-04
146.304	18.288	0.45780E-05
146.304	12.192	0.27774E-04
146.304	6.096	0.22050E-04
146.304	0.000	0.34160E-05
140.208	0.000	0.15694E-04
134.112	0.000	0.33544E-04
128.016	0.000	0.16275E-04
121.920	0.000	0.12159E-04
115.824	0.000	0.43365E-04
109.728	0.000	0.11277E-04
103.632	0.000	0.40859E-04
97.536	0.000	0.22260E-04
91.440	0.000	0.44436E-04
85.344	0.000	0.18417E-04
79.248	0.000	0.58303E-04
73.152	0.000	0.71890E-05
67.056	0.000	0.58303E-04
60.096	0.000	0.18431E-04
54.864	0.000	0.44436E-04
48.768	0.000	0.22274E-04
42.672	0.000	0.40859E-04
36.576	0.000	0.11277E-04
30.480	0.000	0.43365E-04
24.384	0.000	0.12152E-04
18.288	0.000	0.16275E-04
12.192	0.000	0.33544E-04
6.096	0.000	0.15694E-04

TABLE B-15. Estimated 8-Hour Average Concentrations of Particle-Associated 2,4,5-T at Receptor Locations (x, y Coordinates) Around the Perimeter of the Herbicide Orange Site During Excavation

X Coordinate (m)	Y Coordinate (m)	8-Hour Average Concentration (g/m^3)
0.000	0.000	0.12103E-04
0.000	6.096	0.78197E-04
0.000	12.192	0.98483E-04
0.000	18.288	0.16226E-04
0.000	24.384	0.10480E-03
0.000	30.480	0.83300E-04
0.000	36.576	0.50827E-04
0.000	42.672	0.13842E-03
0.000	48.768	0.26719E-04
0.000	54.864	0.15666E-03
0.000	60.960	0.17528E-04
0.000	67.056	0.15666E-03
0.000	73.152	0.26740E-04
0.000	79.248	0.13842E-03
0.000	85.344	0.50862E-04
0.000	91.440	0.83300E-04
0.000	97.536	0.10483E-03
0.000	103.632	0.16226E-04
0.000	109.728	0.98469E-04
0.000	115.824	0.78197E-04
0.000	121.920	0.12110E-04
6.096	121.920	0.55615E-04
12.192	121.920	0.11894E-03
18.288	121.920	0.57715E-04
24.384	121.920	0.43078E-04
30.480	121.920	0.15374E-03
36.576	121.920	0.40005E-04
42.672	121.920	0.14484E-03
48.768	121.920	0.78946E-04
54.864	121.920	0.15751E-03
60.960	121.920	0.65333E-04
67.056	121.920	0.20670E-03
73.152	121.920	0.25473E-04
79.248	121.920	0.20672E-03
85.344	121.920	0.65333E-04
91.440	121.920	0.15757E-03
97.536	121.920	0.78946E-04