Options for specifying Annual Catch Limits (ACLs) for the coral reef fishery in Hawaii, American Samoa, and the Northern Mariana Islands

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WESTERN PACIFIC REGIONAL FISHERY MANAGEMENT COUNCIL

Alternatives for specifying Annual Catch Limits (ACLs) for the coral reef fishery in Hawaii, American Samoa, and the Northern Mariana Islands

Introduction

The 2006 Reauthorization of the Magnuson-Stevens Act required that Regional Fishery Management Councils (RFMC) develop annual catch limits for each of its managed fisheries that may not exceed the fishing level recommendations of its scientific and statistical committee (SSC) or peer review process. Moreover, Councils were required to amend their fishery management plans to establish a mechanism for specifying annual catch limits at a level such that overfishing does not occur in the fishery, including measures to ensure accountability.

The process by which annual catch limits will be implemented has been the focus of much attention by the National Marine Fisheries Service (NMFS) and the Councils through the National SSC Workshops which were convened each year in 2008 to 2010. Among the more difficult stocks of fish to be managed through catch limits are coral reef fish. Coral reef fish landings are highly diverse, with up to 700 species appearing in the Guam and Northern Mariana Islands catch records. While high species diversity is not confined to coral reef fish—West Coast rock fish number in excess of 70 species—reef fisheries are multi-gear fisheries with widely overlapping catch compositions, and with multiple landing sites.

In Guam, Northern Mariana Islands and American Samoa, reef fisheries are sampled by creel intercept surveys of shoreline and boat-based fishing, from which expansions are generated to give annual catches. Samples of catch and effort are small relative to the volume of fishing and expansions thus have wide error distributions. On the other hand, the creel surveys record all fishing so include commercial and non-commercial catches. In Hawaii, all commercial fishermen have to obtain a commercial marine license and submit monthly catch report to the Division of Aquatic Resources, so commercial reef fish catches may be more complete than in other locations. Recreational and subsistence reef fish catches are recorded in the Hawaii Marine Recreational Fisheries Survey (HMRFS) which again is a small sample of the overall effort

In all locations, most reef fish are caught within the coastal zone, either from shore or boats operating along the margins of coastal coral reefs. Fishing does take place, however on offshore banks and reefs but it is currently difficult if not impossible to separate catches between federal and state/territorial waters except for commercial landings in Hawaii. Nonetheless, the requirements for annual catch limits include consideration of all catch and the parsing out of the federal component with respect to setting catch limits. Furthermore, the nature of the coral reef fishery in these island areas is mostly subsistence and recreational with some practicing cultural takes for traditional practices particularly for weddings and funerals. The proportion of commercial from non-commercial harvest is largely unknown. The proportion of the catch landings of each of the primary reef fish families being harvested relative to its respective biomass estimates from underwater visual census surveys (Williams 2009) showed a only a small harvest mortality compared to the large volume of reef fish available for the fishery (Luck and Dalzell 2009). The coral reef fisheries in these island areas are also not highly selective towards a single species. It is characterized by multi-gear harvesting multi-species. Therefore, there is no selective targeted fishery for sharks and other species of concern. If these assemblages became accessible at a given space and time then fishermen rise up to the unique opportunity.

In addition to the operational difficulties in catch recording and monitoring, the vast majority of reef fish have not been studied for life history and demographic parameters. Age and growth rates, longevity and the ages at which reef fish achieve their maximum size and size at maturity provide clues as to their resiliency to fishing. Moreover, estimation of the natural mortality rate, allied to virgin or lightly fished biomass estimates, may provide initial estimates of sustainable yields. Estimation of catch limits for reef fish based on average catches may grossly under or overestimate productivity, and being averages are likely to be exceeded in some years. Further, the federal authority to set limits on reef fish catches may be limited, especially if the majority of catch comes from within the state or territory waters.

The Western Pacific Regional Fishery Management Council had convened a workshop on "Establishing Annual Catch Limits for Coral Reef Fisheries in the Western Pacific Region" from February 1 to 4, 2011 at the Council Office Conference Room. The workshop participants formulated a prioritized set of actions based on the presentations and scientific discussions. Part of the actions was to analyze the fishery dependent data and determine the species that make up 90% of the total catch to determine which species are subject to risk of overfishing. The logic is that targeted or highly harvested species are more at risk than those that are caught in small numbers. However, this assumption does not apply for species that are naturally in low numbers or are rare that even low level of removal can cause a decline in the stock. These species will automatically be separated out and will be dealt with independently.

The process by which the Council will specify ACLs and Accountability Measures on species under the Fishery Ecosystem Plans is described in the Omnibus Amendment document. The Amendment documents also described the process by which ACLs are to be determined if the stock is classified as a Tier 5 stock (a data poor stock with only a time series of catch is available). The coral reef fishery is considered under Tier 5 thus the ABCs will be determined using a certain measure of central tendency and variability over the time series of catch information as guided by (but not limited to) Restrepo et al. 1998. The options presented in this paper are the first among a series of step towards determining actual numbers for ACLs determination for the coral reef fishery in the Western Pacific.

Purpose and need

The purpose of this measure is to determine at what level in the whole coral reef fish stocks should the ACLs be applied. The different levels of species resolution will determine the degree of analysis that will be conducted and the level of resolution by which the ACL management will affect the reef fish stock. The need for the amendment is the requirement put forth by the Reauthorized MSA to manage the coral reef fish stocks using annual catch limits.

Action 1. Alternatives for the level of species aggregation to which the ACLs will be applied

The following alternatives may be considered in determining the level of species aggregation from which the coral reef fish species are to be assigned and analysis shall be conducted. However, there is a proviso where in all these alternatives (except 1.A.), each island area is given a chance to identify species that they would like to be taken out of the aggregations and a separate ACL be specified for them (in the case of extremely rare species).

a. No Action

Under the no-action alternative, the Council would not group individual stocks of coral reef MUS into higher taxonomic groupings or stock complexes. As a result, ACLs would be specified for each individual American Samoa coral reef ecosystem MUS, Hawaii Coral Reef Ecosystem MUS, Mariana Coral Reef Ecosystem MUS (with separate ACLs for Guam and the CNMI) and Pacific Remote Islands Area coral reef ecosystem MUS as they are currently defined in each FEPs. If this approach is selected, ABC and

ACL would be specified annually for over 100 individual coral reef species, dozens coral reef stock complexes listed by family grouping (i.e., Pomacentridae, Scorpaenidae, etc.) and several higher taxonomic orders (i.e., Cephalopods, Gastropoda etc.). For a complete list of coral reef ecosystem MUS for each island area, see the applicable FEP or the implementing regulations for western Pacific FEPs (75 FR 2198, January 10, 2010).

Under this alternative, MSY-based limits and reference points, including ABC and ACLs would continue to be applied to the individual species in a multispecies stock when possible. When this is not possible, they may be specified for one or more species; these values can then be used as indicators for the multi-species stock. When even this is not possible, the multi-species complex as a whole would be used to establish limits and reference points for each area.

Pros	Cons
This approach would allow the Council to meet the ACL requirement without further need to re-classify existing stocks and stock complexes.	This approach would result in several hundred rulemaking actions annually and require an increase in resources and personnel for monitoring catch and processing fisheries data for each individual species, families and groups on a daily basis throughout each fishing year.

b. ACLs be applied on the single aggregated coral reef MUS

Under alternative 1b, all coral reef ecosystem MUS listed under each individual FEP would be grouped into a single multi-species stock complex and a single ACL would be established for the aggregated coral reef ecosystem multi-species stock of each FEP area (with separate ACLs for Guam and the CNMI). To accomplish this, for each year in the available time series, the catch of each individual species and species groups would be pooled and combined to establish a single total catch for the entire coral reef ecosystem stock complex. The available biomass data would be similarly pooled to establish a single total biomass for the entire coral reef ecosystem stock complex. Using these values, the SSC would apply the Tier 5 ABC control rule to recommend an ABC for the coral reef ecosystem stock complex of each FEP area upon which the Council would set an ACL.

Under this approach, the multi-species complex as a whole would be used to establish limits and reference points for each area, consistent with the overfishing provisions for coral reef fisheries as described in each archipelagic FEP.

Pros	Cons
Only a single ACL will be specified for the whole coral reef fish stock complex which will be easier in terms of the analysis and the specification process. Easier to monitor and plot trends over time since all of the CREMUS catches will be summed up annually. No need to increase the resolution of species identification in the creel surveys and catch reporting. Analysis will be simple because it will only require catch and biomass data to evaluate the aggregated stock. Fishermen have the flexibility in targeting any species under the coral reef MUS as long as it is under the catch limit. Aggregated catch to biomass ratio (as an estimate of mortality) will	Will increase the management and monitoring burden for agencies (local and federal). Possible limit to access to the resource affecting fishery development and creates tension between resource managers and stakeholders. The impact of the fishing pressure on the coral reef fish population cannot be determined. There is a chance that the vulnerable species will be overfished and continue may experience overfishing because the effect is masked by other species. Life history and size information cannot be used in a meaningful manner. There will be less

likely to be very small. This would be a similar approach to that of the North Pacific Fishery Management Council for the Bering Sea ground fish complex.	utility of the CPUE data and an estimate of abundance because it cannot be tied up to a particular stock. The biomass component of the catch to biomass ration will likely include species that are not targeted by the fishery thus over-inflating the biomass component resulting in a downwardly biased mortality estimate.

c. ACLs be applied on the family level aggregation that comprise the top 90% of the coral reef fish catch

Under alternative 1.c., all coral reef ecosystem MUS that comprise the top 90% of the coral reef fish catch will be grouped to family level while the remaining 10% will be grouped into a single multi-species stock complex for the purpose of setting ACLs. This will be done for each of the FEP area with Guam and CNMI treated separately. To accomplish this, for each year in the available time series, the individual species under the coral reef MUS would be pooled to their respective taxonomic families. This exercise was done by the Coral Reef Ecosystem Plan Team for the purpose of annual monitoring and reporting on the status of the coral reef MUS. This result in the pooling of the corresponding catch landing for all the species into one family level catch upon which the expansion algorithm will be applied (depending on the method used to catch the fish) to come up with an expanded family level catch. Percentage contribution of each family was calculated relative to the total CREMUS landing and sorted to decreasing value. Cumulative percentages were calculated by adding the respective percentage contribution with the succeeding value until the 90% cut-off was reached. The remaining 10% would be grouped into one multi-species stock complex and will be treated as a minor part of the catch. The assumption here is that the top 90% is the component of the CREMUS that is vulnerable to overfishing while the remaining 10% is otherwise. The 10% group is also characterized by species that intermittently appear in the catch based on the percent occurrence in the catch time series. Using these values, the SSC would apply the Tier 5 ABC control rule to recommend an ABC for the coral reef ecosystem stock complex of each FEP area upon which the Council would set an ACL.

Under this approach, the family level aggregation of the top 90% and the multispecies stock complex that comprise the remaining 10% would be used to establish limits and reference points for each area, consistent with the overfishing provisions for coral reef fisheries as described in each archipelagic FEP.

Pros	**Cons**
Provides higher resolution than a single aggregated MUS and may provide a better biological and ecological characterization. Does not increase the monitoring burden because the catch reporting is summarized on a family level. Provides an optimum level of estimating catch to biomass ratio as an estimate of mortality by limiting the fished and unfished species on a family level. Catch to biomass information is already available. Expanded catch data from creel survey is also available. The assumption that the top 90% is more vulnerable to overfishing than the remaining 10% is a tolerable assumption. Reduces the number of groups that need specification. Provides fisherman some buffer in terms of selecting which groups to targets once one of the families is approaching it's catch limit.	This will increase the number of ACLs that needs to be specified: Am. Samoa = 8 CNMI = 10 Hawaii = 12 Guam = not applicable since the proportion of each family relative to the total is small and all of the family level groupings only made up 85% of the total reef fish catch; results will be similar to Alternative 1.D. Cannot maximize the use of life history, CPUE, size structure information. Size structure information will be affect mostly by the species composition within the family. The fishing pressure

	can still increase on a particular species and could cause it to become overfished without any indications in the overall landing trends. Changes in biomass, abundance and size over time (as an indicator if population status) cannot be directly compared with the harvested stock and would depend on what is dominant in the family. The biomass are not estimated on an annual basis, thus it is not feasible to assess the stock status on an annual basis if using biomass as a measure for stock abundance. Annual assessments are needed as part of the accountability measure.

d. ACLs be applied on the family level

Under alternative 1.d., all coral reef ecosystem MUS will be grouped to family level. This will be done for each of the FEP area with Guam and CNMI treated separately. To accomplish this, for each year in the available time series, the individual species under the coral reef MUS would be pooled to their respective taxonomic families. This exercise was done by the Coral Reef Ecosystem Plan Team for the purpose of annual monitoring and reporting on the status of the coral reef MUS. This result in the pooling of the corresponding catch landing for all the species into one family level catch upon which the expansion algorithm will be applied (depending on the method used to catch the fish) to come up with an expanded family level catch. Using these values, the SSC would apply the Tier 5 ABC control rule to recommend an ABC for the coral reef ecosystem stock complex of each FEP area upon which the Council would set an ACL. The family groupings are an established taxonomic grouping and are listed as the currently and potentially harvested coral reef taxa in the FEP. The general groupings (i.e. other finfish, miscellaneous reef fish, bottomfish) are aggregations of species listed under the FEP and also those caught in the coral reef fishery that cannot be identified.

Under this approach, the family level aggregation would be used to establish limits and reference points for each area, consistent with the overfishing provisions for coral reef fisheries as described in each archipelagic FEP.

Pros	**Cons**
Provides higher resolution than a single aggregated MUS and may provide a better biological and ecological characterization. Does not increase the monitoring burden because the catch reporting is summarized on a family level. Provides an optimum level of estimating catch to biomass ratio as an estimate of mortality by limiting the fished and unfished species on a family level. Catch to biomass information is already available. Expanded catch data from creel survey is also available. Provides a full array of ACLs specific to each family thereby reducing the uncertainties. Provides fisherman some buffer in terms of selecting which groups to targets once one of the families is approaching it's catch limit.	This will increase the number of ACLs that needs to be specified more than Alternative 1.B. and 1.C.: Am. Samoa = 16 CNMI = 16 Guam = 18 Hawaii = 31 Cannot maximize the use of life history, CPUE, size structure information. Size structure information will be affect mostly by the species composition within the family. The fishing pressure can still increase on a particular species and could cause it to become overfished without any indications in the overall landing trends. Changes in biomass, abundance and size over time (as an indicator if population status) cannot be directly

	compared with the harvested stock and would depend on what is dominant in the family. The biomass are not estimated on an annual basis, thus it is not feasible to assess the stock status on an annual basis if using biomass as a measure for stock abundance. Annual assessments are needed as part of the accountability measure.

e. ACLs be applied on the highest taxonomic resolution available in the fishery database that comprise the top 90% of the coral reef fish catch

Under alternative 1.e., all coral reef ecosystem MUS identified to the highest taxonomic level possible that comprise the top 90% of the coral reef fish catch while the remaining 10% will be grouped into a single multi-species stock complex for the purpose of setting ACLs. This will be done for each of the FEP area with Guam and CNMI treated separately. To accomplish this, for each year in the available time series, the raw catch landing of the individual species under the coral reef MUS would extracted and summed from the fishery database. Percentage contribution of each family was calculated relative to the total landing and sorted to decreasing value. Cumulative percentages were calculated by adding the respective percentage contribution with the succeeding value until the 90% cut-off was reached. The remaining 10% would be grouped into one multi-species stock complex and will be treated as a minor part of the catch. In order to get an expanded value of the raw catch total per year, the percentage contribution of that species was multiplied with the expanded landing of its corresponding family. The assumption here is that the top 90% is the components of the coral reef species catches are vulnerable to overfishing while the remaining 10% is otherwise. The 10% group is also characterized by species that intermittently appear in the catch based on the percent occurrence in the catch time series. Using these values, the SSC would apply the Tier 5 ABC control rule to recommend an ABC for the coral reef ecosystem stock complex of each FEP area upon which the Council would set an ACL.

Under this approach, the species level resolution of the top 90% and the multispecies stock complex that comprise the remaining 10% would be used to establish limits and reference points for each area, consistent with the overfishing provisions for coral reef fisheries as described in each archipelagic FEP.

Pros	Cons
The ACLs that will be generated will be more accurate and could have more impact in ensuring that the species is not overfished (assuming that there is reliable data that goes into the process). The life history, biomass, habitat, catch, CPUE and size frequency trends can be maximized and can be used as auxiliary information in determining the status of the stock if no stock assessment information is available. This will be more "scientifically rigorous". One has a good handle on the vulnerability of the species to overfishing because there is more information that feeds into the ACL specification. This alleviates the need for identifying vulnerable species and has the option to add "naturally rare" species.	The analysis will be very cumbersome. The amount of species for ACL specification, even considering only the top species and that occurred in most of the time series, is enormous: Am. Samoa = 27 species (12 in family/group) CNMI = 30 species (14 in family/group) Guam = 81 species (only 4 in family/group) Hawaii = 23 species (4 in family/group) There is a tendency that the data will be over analyzed compared to the process specified by the Omnibus Amendment where for tier 5 stocks (basically the coral reef MUS) only average of recent catch will be used to estimate the ABCs. Species level expanded data is not available for

	catch and biomass thus will have to be extrapolated from the proportion of each species to the total annual catch from the raw catch landing data (same goes with biomass from the census surveys). However, such procedure will result in a similar temporal trend for all species under that particular family and the only variation will be the level relative to the overall family level catch. Additional burden placed on NMFS to improve the database and data collection and enhance the resolution of the creel survey and log books to species level identification.

On specifying the level of aggregation of the coral reef stock complex for ACL specification, the SSC's preferred alternative(s) is/are:

1.A. No Action;
1.B. ACLs be applied on the single aggregated coral reef MUS;
1.C. ACLs be applied on the family level aggregation that comprise the top 90% of the coral reef fish catch;
1.D. ACLs be applied on the family level aggregation;
1.E. ACLs be applied on the highest taxonomic resolution available in the fishery database that comprise the top 90% of the coral reef fish catch

Action 2. Alternatives for defining mean of recent catch

Based on the action stated above, the SSC may choose to an array of means of the catch estimates upon which the Tier 5 Control Rule will be applied. There are several metrics to choose from but generally choosing between using an arithmetic mean with 1 or 2 standard deviations above the mean or a geometric mean (one tailed mean) with the 75^{th} or 95^{th} percentile. The arithmetic mean takes into consideration extreme values thereby inherently incorporating a larger fluctuation in the data set while geometric means tend to minimize the effect of extreme values and the effects are limited to the true fluctuation of the data. The standard deviation added to the mean incorporates the variabilities and uncertainties above the mean. The 75^{th} percentile would describe catch values that made up 75% of the data, similarly with the 95^{th} percentile with 95% of the data.

LIST OF ALTERNATIVES FOR ACL SPECIFICATION IN THE CORAL REEF FISHERY IN AMERICAN SAMO

Alternative 1.A. No Action

Alternative 1.B.: All CREMUS groupings aggregated

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
ALL CREMUS	105,403	45,534	150,937	196,471	97,332	126,610	166,541

Alternative 1.C.Top 90% of CREMUS landing and rest of 10% binned together

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Surgeonfish	16,261	12,229	28,490	40,719	12,838	19,516	37,175
Snapper	15,850	7,025	22,875	29,900	14,324	21,607	27,391
Jacks	8,223	6,996	15,220	22,216	6,304	10,868	17,077
Emperor	7,667	4,509	12,175	16,684	6,185	10,255	15,112
Parrotfish*	6,311	6,654	12,965	19,619	3,959	8,145	18,278
Grouper	6,159	1,801	7,961	9,762	5,904	7,632	8,756
Squirrelfish	2,759	2,477	5,236	7,713	2,087	2,585	7,304
Remaining 10%	27,555	32,292	59,847	92,139	17,926	31,497	75,539

Alternative 1.D.: Individual CREMUS groupings

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Surgeonfish	16,261	12,229	28,490	40,719	12,838	19,516	37,175
Snapper	15,850	7,025	22,875	29,900	14,324	21,607	27,391
Jacks	8,223	6,996	15,220	22,216	6,304	10,868	17,077
Emperor	7,667	4,509	12,175	16,684	6,185	10,255	15,112
Parrotfish*	6,311	6,654	12,965	19,619	3,959	8,145	18,278
Grouper	6,159	1,801	7,961	9,762	5,904	7,632	8,756
Squirrelfish	2,759	2,477	5,236	7,713	2,087	2,585	7,304
Atule	14,060	29,337	43,397	72,733	2,330	8,396	63,722
Mullets	2,679	4,336	7,015	11,351	1,054	2,857	7,727
Goatfish	550	438	988	1,425	310	847	1,332
Wrasse**	949	1,221	2,170	3,392	492	1,253	3,004
Rabbitfish	134	162	296	458	84	126	388
Rudderfish	573	452	1,025	1,477	319	843	1,323
Mollusk	11,601	9,431	21,032	30,462	6,058	16,694	27,001
Crustacean	1,967	1,463	3,430	4,893	1,550	2,248	4,788
Other fin fish***	13,021	7,550	20,571	28,121	11,011	17,124	25,178

NOTE: * excludes Bolbometopon muricatum (bumphead parrotfish)
** excludes Cheilinus undulatus (humphead wrasse)
*** includes reef sharks

LIST OF ALTERNATIVES FOR ACL SPECIFICATION IN THE CORAL REEF FISHERY IN CNMI

Alternative 1.A. No Action

Alternative 1.B.: All CREMUS groupings aggregated

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
ALL CREMUS	73,938	31,361	105,299	136,660	67,317	100,725	106,668

Alternative 1.C.: Top 90% of CREMUS landing and rest of 10% binned together

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Emperor	23,413	11,827	35,240	47,066	19,730	27,466	39,186
Jacks	14,968	8,456	23,424	31,879	12,674	21,512	26,607
Surgeonfish	5,517	2,706	8,223	10,929	4,924	6,884	9,469
Atule	5,024	4,922	9,946	14,868	2,471	7,459	12,419
Grouper	4,220	1,644	5,864	7,507	3,828	5,519	6,179
Snapper	3,367	1,697	5,064	6,760	3,050	3,905	5,968
Goatfish	3,323	2,917	6,239	9,156	2,083	3,670	7,972
Parrotfish*	2,672	1,581	4,253	5,833	2,239	3,784	4,832
Other fin fish***	3,445	2,460	5,905	8,364	2,327	5,787	6,024
Remaining 10%	10,868	9,296	20,164	29,460	7,516	16,954	25,153

Alternative 1.D.: Individual CREMUS groupings

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Emperor	23,413	11,827	35,240	47,066	19,730	27,466	39,186
Jacks	14,968	8,456	23,424	31,879	12,674	21,512	26,607
Surgeonfish	5,517	2,706	8,223	10,929	4,924	6,884	9,469
Atule	5,024	4,922	9,946	14,868	2,471	7,459	12,419
Grouper	4,220	1,644	5,864	7,507	3,828	5,519	6,179
Snapper	3,367	1,697	5,064	6,760	3,050	3,905	5,968
Goatfish	3,323	2,917	6,239	9,156	2,083	3,670	7,972
Parrotfish*	2,672	1,581	4,253	5,833	2,239	3,784	4,832
Other fin fish***	3,445	2,460	5,905	8,364	2,327	5,787	6,024
Mollusk	2,693	3,194	5,887	9,080	853	4,446	7,188
Mullets	2,268	1,427	3,694	5,121	1,536	3,308	3,915
Rabbitfish	1,441	1,427	2,868	4,295	660	2,537	3,633
Squirrelfish	1,307	1,400	2,707	4,107	798	1,311	3,646
Wrasse**	902	1,056	1,959	3,015	383	1,200	2,670
Rudderfish	600	303	903	1,206	530	706	1,022
Crustacean	n/d	n/d	n/d	n/d	n/d	n/d	n/d

NOTE: * excludes Bolbometopon muricatum (bumphead parrotfish)
** excludes Cheilinus undulatus (humphead wrasse)
*** includes reef sharks

LIST OF ALTERNATIVES FOR ACL SPECIFICATION IN THE CORAL REEF FISHERY IN GUAM

Alternative 1.A. No Action

Alternative 1.B.: All CREMUS groupings aggregated

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
ALL CREMUS	383,486	140,186	523,671	663,857	359,228	482,319	576,494

Alternative 1.C.: Top 90% of CREMUS landing and rest of 10% binned together

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
	NOT APPLICABLE FOR GUAM DATA				NOT APPLICABLE FOR GUAM DATA		

Alternative 1.D.: Individual CREMUS groupings

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Surgeonfish	59,261	23,308	82,569	105,877	55,015	70,702	101,923
Jacks	38,755	15,313	54,069	69,382	36,360	45,377	60,072
Atule	36,143	38,937	75,081	114,018	18,473	56,514	115,064
Emperor	31,554	12,601	44,155	56,756	29,026	38,720	52,643
Parrotfish*	22,146	10,501	32,646	43,147	19,574	28,649	36,477
Goatfish	20,916	9,981	30,897	40,878	18,423	25,367	40,462
Mollusk	20,812	18,126	38,938	57,065	16,788	21,941	43,294
Rabbitfish	20,329	8,321	28,650	36,972	18,560	26,120	29,910
Snappers	14,241	4,854	19,095	23,949	13,413	17,726	19,807
Groupers	14,040	5,754	19,794	25,548	12,894	17,958	21,653
Mullets	10,598	7,533	18,132	25,665	7,840	15,032	23,781
Rudderfish	9,901	5,582	15,483	21,064	8,457	13,247	19,011
Crustacean	6,134	3,747	9,880	13,627	5,203	7,890	12,760
Squirrelfish	6,086	3,771	9,856	13,627	5,135	8,300	12,390
Algae	5,159	8,387	13,546	21,933	1,555	5,329	21,610
Wrasse	3,855	2,613	6,469	9,082	3,001	5,195	8,184
Sp. of concern***	8,113	7,362	15,476	22,838	5,582	8,673	22,422
Other CREMUS****	55,657	30,700	86,357	117,057	47,797	83,214	109,806

NOTE:
* excludes Bolbometopon muricatum (bumphead parrotfish)
** excludes Cheilinus undulatus (humphead wrasse)
*** includes reef sharks, C. undulatus, B. muricatum
**** includes uni'd fish and other sp. and comprise the remaining 15% of the CREMUS catch

LIST OF ALTERNATIVES FOR ACL SPECIFICATION IN THE CORAL REEF FISHERY IN HAWAII

Alternative 1.A. No Action

Alternative 1.B.: All CREMUS groupings aggregated

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
ALL CREMUS	204,364	43,288	247,652	290,940	199,848	239,505	271,057

Alternative 1.C.: Top 90% of CREMUS landing and rest of 10% binned together

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Jacks	49,150	23,490	72,640	96,131	43,579	67,205	94,221
Surgeonfish	31,026	7,610	38,635	46,245	30,105	36,884	43,059
Goatfish	29,885	13,863	43,749	57,612	25,062	36,360	53,942
Snappers	22,139	10,453	32,592	43,045	16,827	28,928	35,712
Squirrelfish	15,868	5,820	21,688	27,508	14,609	19,802	24,662
Parrotfish	11,667	6,425	18,092	24,517	9,217	16,260	20,698
Bonefish	6,885	4,836	11,721	16,557	5,228	9,835	16,351
Reef sharks	6,323	9,922	16,245	26,166	1,831	8,233	22,806
Barracuda	6,193	5,437	11,630	17,067	5,005	7,315	11,281
Rudderfish	5,740	2,842	8,582	11,423	5,071	7,066	10,171
Mullets	5,264	2,828	8,093	10,921	4,585	6,705	10,693
Other CREMUS	16,237	4,108	20,345	24,453	15,727	18,298	23,031

Alternative 1.D.: Individual CREMUS groupings

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Jacks	49,150	23,490	72,640	96,131	43,579	67,205	94,221
Surgeonfish	31,026	7,610	38,635	46,245	30,105	36,884	43,059
Goatfish	29,885	13,863	43,749	57,612	25,062	36,360	53,942
Snappers	22,139	10,453	32,592	43,045	16,827	28,928	35,712
Squirrelfish	15,868	5,820	21,688	27,508	14,609	19,802	24,662
Parrotfish	11,667	6,425	18,092	24,517	9,217	16,260	20,698
Bonefish	6,885	4,836	11,721	16,557	5,228	9,835	16,351
Reef sharks	6,323	9,922	16,245	26,166	1,831	8,233	22,806
Barracuda	6,193	5,437	11,630	17,067	5,005	7,315	11,281
Rudderfish	5,740	2,842	8,582	11,423	5,071	7,066	10,171
Mullets	5,264	2,828	8,093	10,921	4,585	6,705	10,693
Wrasse	3,532	1,256	4,787	6,043	3,309	4,191	5,922
Bigeye soldier	2,387	1,262	3,649	4,911	2,123	2,648	4,989
Flagtails	2,062	896	2,958	3,854	1,878	2,548	3,338
Threadfins	1,627	2,090	3,717	5,807	836	1,906	5,330
Lionfish	1,279	485	1,763	2,248	1,179	1,661	2,028
Moray eels	1,022	1,106	2,128	3,234	366	1,850	2,950
Emperors	910	747	1,657	2,405	611	1,209	2,066
Puffers	892	1,933	2,825	4,757	325	816	2,957
Damselfish	823	324	1,147	1,471	762	970	1,367
Triggerfish	403	369	772	1,141	222	610	1,105
Halfbeaks	323	617	940	1,557	138	211	2,060
Conger eels	295	272	567	839	165	483	752
Grouper roi only	390	300	691	991	313	470	919
Hawkfish	302	156	458	614	252	400	575
Trumpetfish	49	40	90	130	36	60	132
Butterflyfish	83	85	168	253	44	79	237
Apogons	47	67	114	182	19	48	221
Eagle ray	70	112	182	294	21	75	311
Boxfish	41	134	176	310	9	25	70
Solefish	15	14	28	42	10	18	36

NOTE:
* excludes Bolbometopon muricatum (bumphead parrotfish)
** excludes Cheilinus undulatus (humphead wrasse)
*** includes reef sharks, C. undulatus, B. muricatum
**** includes uni'd fish and other sp. & comprise the remaining 15% of the CREMUS catch

On specifying the metrics in defining mean of recent catch, the SSC's preferred alternative(s) is/are:

2.A. use arithmetic mean of recent catch;
2.B. use 1standard deviation above the arithmetic mean of recent catch;
2.C. use 2 standard deviation above the arithmetic mean of recent catch;
2.D. use geometric mean;
2.E. use 75th percentile;
2.F. use 95th percentile

Action 3. Alternatives for application of Tier 5 ABC Control Rule

For data poor fisheries where only catch history is available, the Council's default ABC control rule (Tier 5) directs the SSC to multiply the average catch from a time period where there is no quantitative or qualitative evidence of declining abundance ("Recent Catch") by a factor based on a qualitative estimate of relative stock size. The following guidelines are provided in the FEPs:

Above BMSY	Limit catch to 1.00*Recent Catch
Above MSST but below BMSY	Limit catch to 0.67*Recent Catch
Below MSST (i.e. overfished)	Limit catch to 0.33*Recent Catch

However, the FEPs allow the SSC to recommend an ABC that differs from the result of the ABC control rule calculation, based on factors such as data uncertainty, recruitment variability, declining or increasing trends in population variables, and other factors. If the stock is deemed underutilized (could be based on catch to biomass ratio and ancillary information presented in the appendices) then a revised control rule of 2 or 3 times the preferred recent catch mean. This would ensure that any ACLs to be established will not interfere with any potential fishery development in the island areas.

On applying the Tier 5 ABC Control Rule, the SSC's preferred alternative(s) is/are:

3.A. No Action – will use default control rule with 1.00 being the maximum multiplier when B>Bmsy
3.B. Utilize a factor above 1 as multiplier to the recent catch if the stock is under utilized

Action 4. Alternatives for establishing accountability measures in the coral reef fishery

Accountability measures for the coral reef MUS will be challenging. Monitoring of catches will continue by the State of Hawaii's Division of Aquatic Resources, and the WPacFIN creel surveys for the three US Territories, but in-season catch totals can be examined by NMFS to determine if any catches are likely to exceed the specified ACL. Evaluation of catches and stock status will need to be conducted by the archipelagic Plan Teams to assess if any overages would lead to overfishing of the stock. The Plan teams will also need to consider the relative proportions of catches made within State/Territorial and Federal waters and what State/Territory regulations may apply to a given stock. With the current quality of data collection and the local capacity to monitor the coral reef catch in mind, the SSC may want to consider the following alternatives in establishing accountability measures in the coral reef fishery:

4.A. No Action. Under this alternative, the Council would not identify an AM to ensure the ACL is not exceeded. NMFS would monitor catch throughout the fishing year based on all available catch data (local and federal, where available). However, if an ACL was exceeded, the Council would determine the appropriate overage adjustment for the following fishing year. If the ACL for any stock/stock complex is exceeded more than once in a four year period, the Council will re-evaluate the system of ACLs and AMs and modify the system as necessary to improve its performance and effectiveness .

4.B. In-season closure. Under this alternative, an in-season closure would be implemented so that when the ACL for a stock/stock complex is projected to be reached, NMFS would close the fishery or fisheries, as appropriate to ensure the ACL is not exceeded. Like the Alternative 4.A, if an ACL was exceeded, the Council would determine the appropriate overage adjustment for the following fishing year. If the ACL for any stock/stock complex is exceeded more than once in a four year period, the Council will re-evaluate the system of ACLs and AMs and modify the system as necessary to improve its performance and effectiveness .

4.C. In-season closure with Annual Catch Target. Like Alternative 4.B., an in-season closure would be implemented to ensure the ACL for a stock/stock complex is not exceeded. However, instead of closing the fishery or fisheries when the ACL is projected to be reached, the fishery would be closed when the ACT was projected to be reached. The ACT would be set at a certain percent below the ACL to account for management uncertainty. However, since no coral reef fishery has been managed using catch limits, data is not yet available to determine the percentage reduction at this time.

Identifying the level of aggregation and defining groups for ACL specification

CREMUS/Family level

1. American Samoa
2. Commonwealth of Northern Mariana Islands
3. Guam
4. Hawaii

Table 1. CREMUS groups that comprise the top 90% of the coral reef catch in American Samoa

CREMUS Group	Total	%contrib	cumm%
Surgeonfish	308,950	15.43	15.43
Snappers	301,148	15.04	30.46
Atulai	239,024	11.94	42.40
Mollusks	197,222	9.85	52.25
Jacks	156,244	7.80	60.05
Emperors	145,665	7.27	67.32
Parrotfish	119,908	5.99	73.31
Groupers	117,029	5.84	79.15
Other Invertebrates	93,831	4.69	83.84
Other CRE-Finfish	76,463	3.82	87.66
Squirrelfish	52,418	2.62	90.27
Mullet	42,864	2.14	92.42
Misc. Bottomfish	38,668	1.93	94.35
Misc. Reeffish	38,084	1.90	96.25
Crustaceans	37,369	1.87	98.11
Wrasse	15,179	0.76	98.87
Rudderfish	10,312	0.51	99.39
Goatfish	9,349	0.47	99.85
Rabbitfish	2,281	0.11	99.97
Reef Sharks	354	0.02	99.98
Algae	272	0.01	100.00
Napoleon Wrasse	32	0.00	100.00
Misc. Shallow bottomfish	0	0.00	100.00
Bumphead Parrotfish	0	0.00	100.00

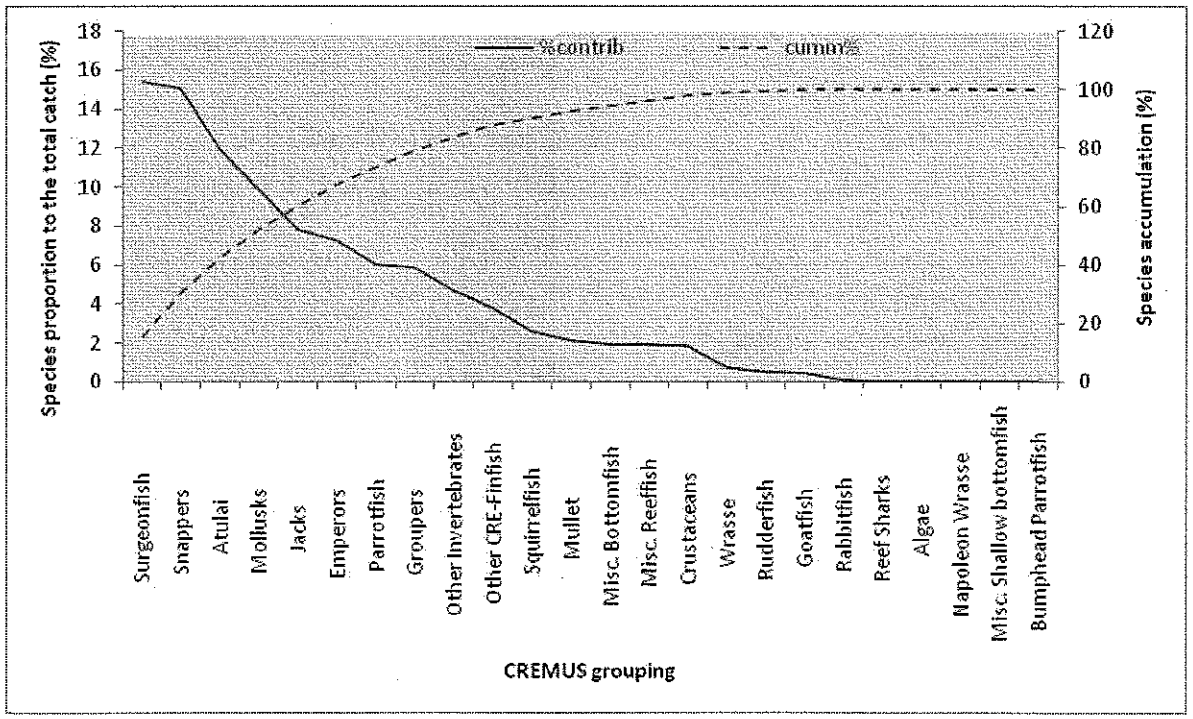


Table 2. CREMUS groups that comprise the top 90% of the coral reef catch in the Commonwealth of Northern Mariana Islands.

CREMUS Group	Total	%contrib	cumm%
Emperors	210,717	31.67	31.67
Jacks	134,710	20.24	51.91
Surgeonfish	49,649	7.46	59.37
Atulai	45,215	6.79	66.16
Groupers	37,978	5.71	71.87
Snappers	30,304	4.55	76.43
Goatfish	29,903	4.49	80.92
Parrotfish	29,156	4.38	85.30
Other Finfish	27,216	4.09	89.39
Mollusks	16,158	2.43	91.82
Mullet	13,605	2.04	93.86
Rabbitfish	12,969	1.95	95.81
Squirrelfish	11,761	1.77	97.58
Wrasse	8,121	1.22	98.80
Rudderfish	4,198	0.63	99.43
Misc. Reeffish	3,663	0.55	99.98
Napoleon Wrasse	66	0.01	99.99
Misc. Bottomfish	57	0.01	100.00
Misc. Shallow bottomfish	-	0.00	100.00
Bumphead Parrotfish	-	0.00	100.00
Reef Sharks	-	0.00	100.00
Crustaceans	-	0.00	100.00
Other Invertebrates	-	0.00	100.00
Algae	-	0.00	100.00

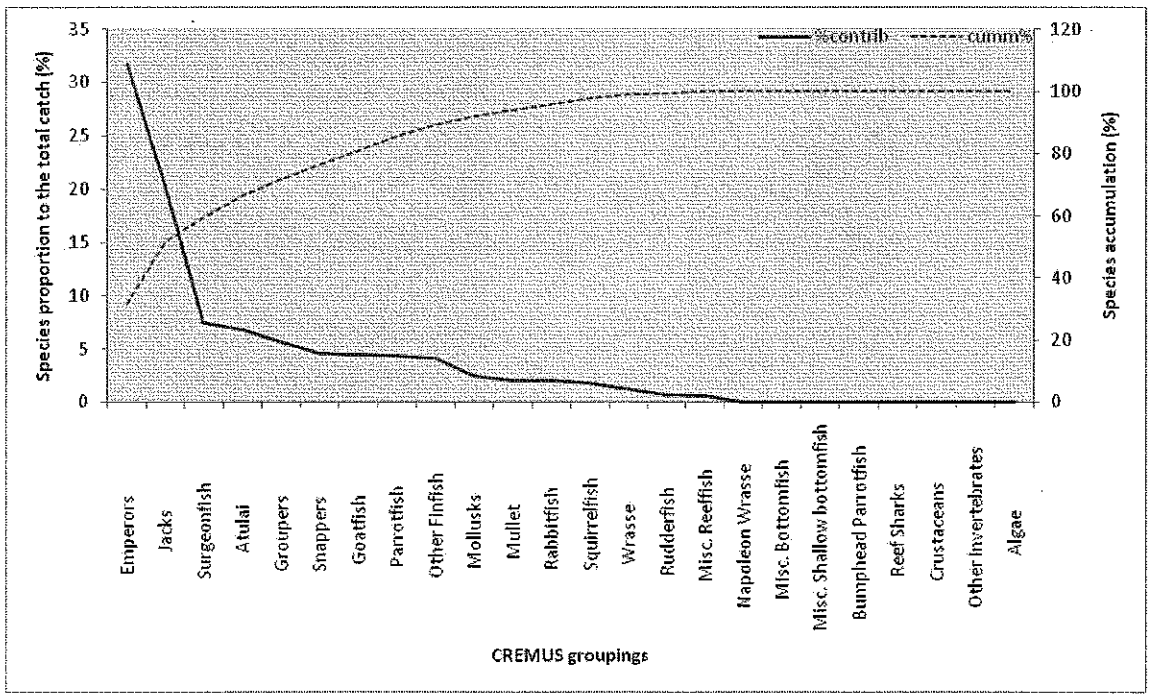


Table 3. Species and species groups that comprise the top 90% of the coral reef catch in the Guam.

CREMUS Group	Total	%contrib	cumm%
Surgeonfish	1,422,263	15.45	15.45
Jacks	930,127	10.11	25.56
Atulai	867,442	9.42	34.98
Other CRE-Finfish	763,148	8.29	43.28
Emperors	757,290	8.23	51.50
Parrotfish	531,492	5.77	57.28
Goatfish	501,977	5.45	62.73
Mollusks	499,493	5.43	68.16
Rabbitfish	487,905	5.30	73.46
Misc. Reeffish	351,660	3.82	77.28
Snappers	341,795	3.71	81.00
Groupers	336,949	3.66	84.66
Mullet	254,362	2.76	87.42
Rudderfish	237,629	2.58	90.00
Misc. Shallow bottomfish	170,537	1.85	91.86
Crustaceans	147,209	1.60	93.45
Squirrelfish	146,054	1.59	95.04
Reef Sharks	143,925	1.56	96.61
Algae	118,662	1.29	97.89
Wrasse	92,529	1.01	98.90
Napoleon Wrasse	47,880	0.52	99.42
Other Invertebrates	44,962	0.49	99.91
Misc. Bottomfish	5,454	0.06	99.97
Bumphead Parrotfish	2,917	0.03	100.00

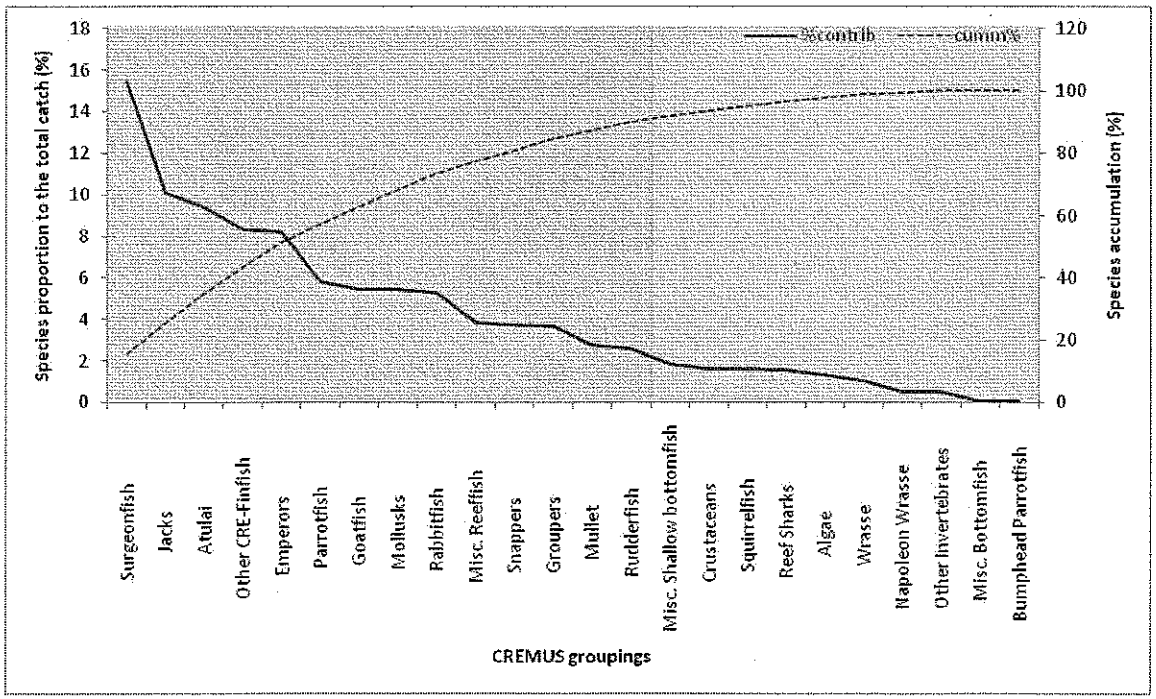
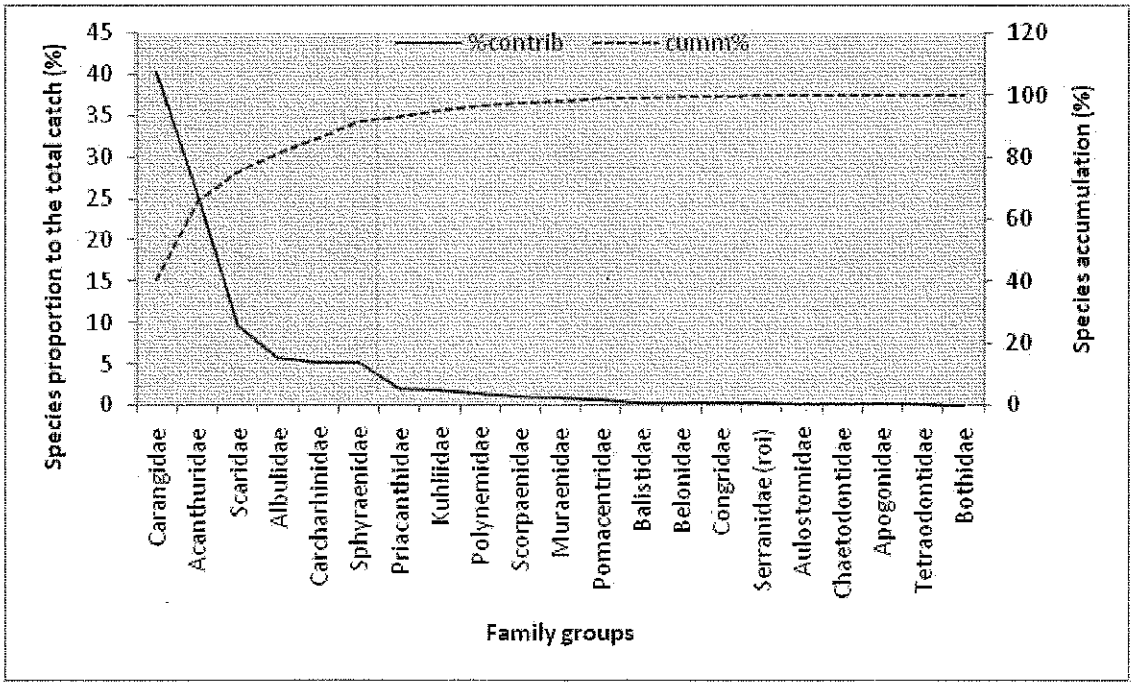


Table 4. Reef fish families that comprise the top 90% of the coral reef catch in Hawaii.

Family	Total	%contrib	cumm%
Carangidae	2,162,616	40.32	40.32
Acanthuridae	1,365,125	25.45	65.77
Scaridae	513,357	9.57	75.34
Albulidae	302,918	5.65	80.99
Carcharhinidae	278,219	5.19	86.17
Sphyraenidae	272,476	5.08	91.25
Priacanthidae	105,046	1.96	93.21
Kuhliidae	90,736	1.69	94.90
Polynemidae	71,586	1.33	96.24
Scorpaenidae	56,256	1.05	97.29
Muraenidae	44,980	0.84	98.13
Pomacentridae	36,191	0.67	98.80
Balistidae	17,735	0.33	99.13
Belonidae	14,229	0.27	99.40
Congridae	12,963	0.24	99.64
Serranidae (roi)	11,707	0.22	99.86
Aulostomidae	2,174	0.04	99.90
Chaetodontidae	1,818	0.03	99.93
Apogonidae	1,790	0.03	99.97
Tetraodontidae	1,243	0.02	99.99
Bothidae	628	0.01	100.00



Identifying the level of aggregation and defining groups for ACL specification

Species level or species groups

1. American Samoa
2. Commonwealth of Northern Mariana Islands
3. Guam
4. Hawaii

Table 5. Species and species groups that comprise the top 90% of the coral reef catch in American Samoa.

Species Name	$Total_{catch}$	Ave_{catch}	$Total_{occur}$	$\%tot_{catch}$	$\%ave_{catch}$	$\%tot_{occur}$	$cumm\%_{ave}$
Selar crumenopthalmus	12,281	682	18	8	8	75	8
Lutjanus kasmira	10,878	453	24	7	5	100	15
REEF FISH	10,151	534	19	7	6	79	21
SCARIDAE	9,724	423	23	6	5	96	28
Acanthurus lineatus	9,709	422	23	6	5	96	34
Lujanus gibbus	8,117	338	24	5	4	100	39
SPHYRAENIDAE	8,070	336	24	5	4	100	44
Aprion virescens	8,056	336	24	5	4	100	50
LETHRINIDAE	7,338	306	24	5	4	100	54
Variola louti	6,146	256	24	4	3	100	58
Lethrinus rubrioperculatus	5,819	291	20	4	4	83	62
CARANGIDAE	5,445	237	23	4	3	96	66
Sphyraena spp.	5,036	240	21	3	3	88	69
HOLOCENTRIDAE	4,619	192	24	3	2	100	72
Lethrinus microdon	4,282	195	22	3	2	92	75
Naso spp.	4,202	191	22	3	2	92	77
SERRANIDAE	3,088	129	24	2	2	100	79
Elegatis bipinnulata	2,723	113	24	2	1	100	81
Lethrinus ambonensis	2,642	176	15	2	2	63	83
Ctenochaetus striatus	2,515	157	16	2	2	67	84
Cephalopholis sonnerati	2,094	87	24	1	1	100	86
MUGILIDAE	1,461	70	21	1	1	88	87
Mulloidichthys spp.	1,314	73	18	1	1	75	88
Naso lituratus	1,300	62	21	1	1	88	88
Seriola dumerili	1,247	249	5	1	3	21	89
Inshore serranids	1,082	90	12	1	1	50	90
Acanthurus nigrofuscus	957	48	20	1	1	83	91

Figure 1. Percentage contribution of each species/species groups to the total coral reef fish catch in American Samoa

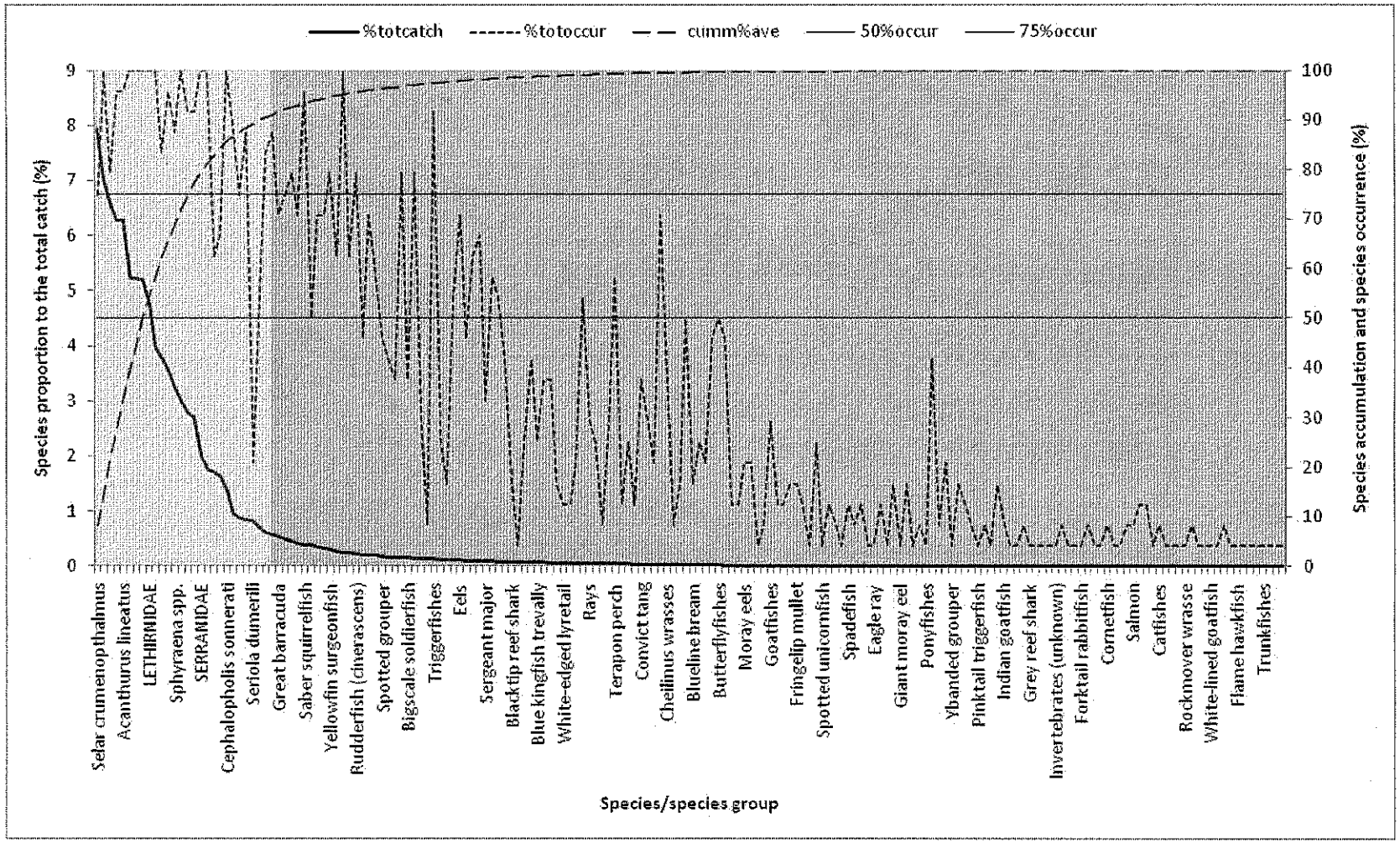


Table 6. Species and species groups that comprise the top 90% of the coral reef catch in the Commonwealth of Northern Mariana Islands.

Species Name	$Total_{catch}$	$Total_{occur}$	$\%tot_{catch}$	$\%tot_{occur}$	cumm%
Lethrinus rubrioperculatus	1,852	10	27	100	27
LETHRINIDAE	677	10	10	100	37
Lenthrinus harak	506	6	7	60	44
SCARIDAE	354	10	5	100	49
Epinephelus fasciatus	272	10	4	100	53
Naso lituratus	204	10	3	100	56
Siganus fuscescens	175	10	3	100	59
Lethrinus olivaceus	175	10	3	100	61
MULLIDAE	174	10	3	100	64
BALISTIDAE	173	10	3	100	66
ACANTHURIDAE	147	8	2	80	68
HOLOCENTRIDAE (squirrel)	138	9	2	90	70
Lutjanus kasmira	130	10	2	100	72
Variola louti	128	8	2	80	74
Naso unicornis	115	10	2	100	76
KYPHOSIDAE	110	7	2	70	78
NASO spp	108	9	2	90	79
Lethrinus obsoletus	103	8	2	80	81
MUGILIDAE	98	7	1	70	82
Lethrinus xanthochilus	76	6	1	60	83
SERRANIDAE	74	10	1	100	84
LABRIDAE	71	10	1	100	85
Lethrinus atkinsoni	57	5	1	50	86
Acanthurus lineatus	57	7	1	70	87
Cephalopholis urodeta	55	8	1	80	88
HOLOCENTRIDAE (soldier)	48	9	1	90	88
Acanthurus xanthopterus	45	6	1	60	89
LUTJANIDAE	40	5	1	50	90
BELONIDAE	40	5	1	50	90
Siganus punctatus	35	5	1	50	91

Figure 2. Percentage contribution of each species/species groups to the total coral reef fish catch in the Commonwealth of Northern Mariana Islands.

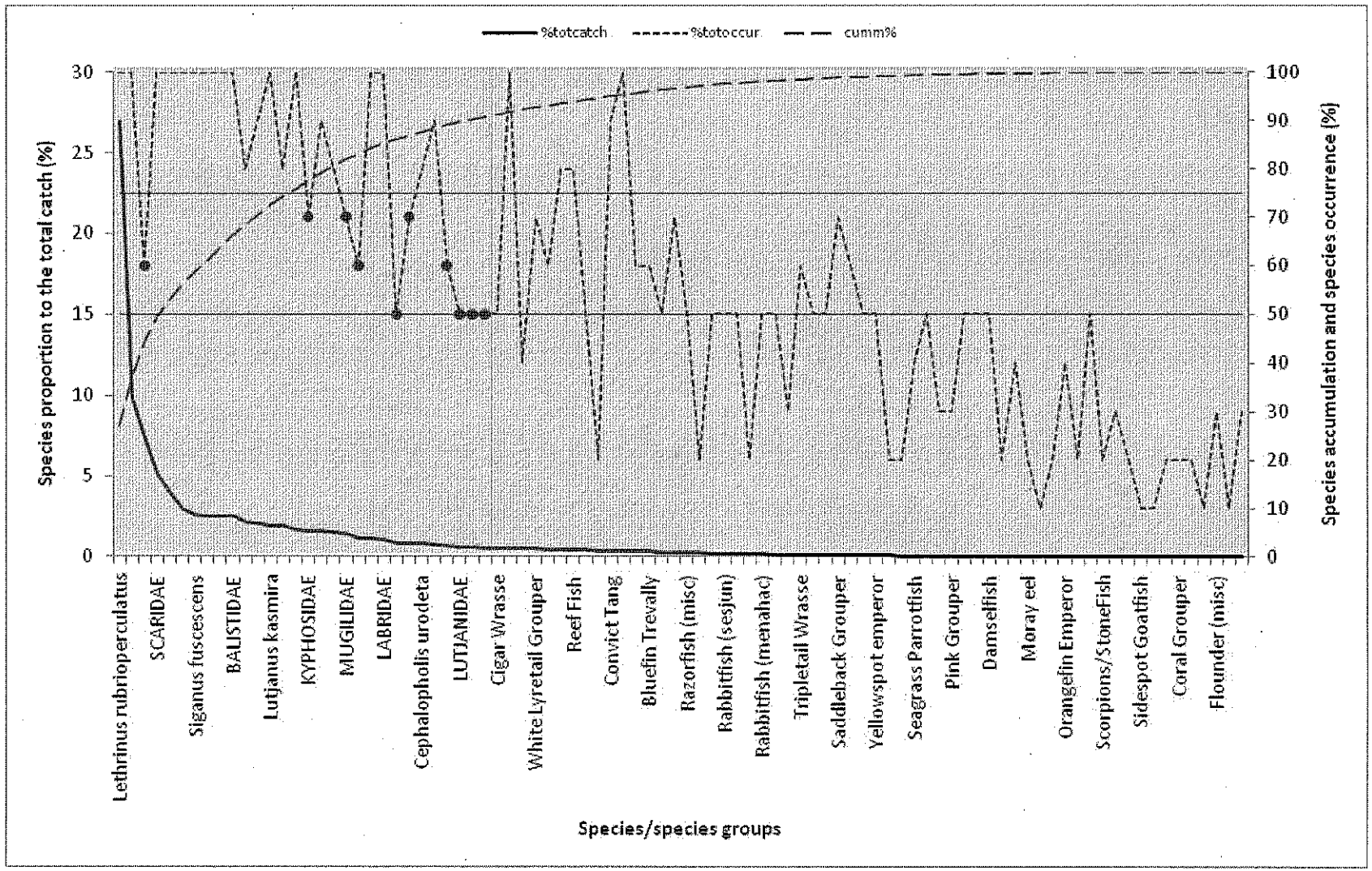


Table 7. Species and species groups that comprise the top 90% of the coral reef catch in the Guam.

Species Name	$Total_{catch}$	$Total_{occur}$	$\%tot_{catch}$	$\%tot_{occur}$	cumm%
ASSORTED REEF FISH	5566	23	8	82	8
Naso unicornis	5310	27	8	96	16
Lethrinus rubrioperculatus	4945	28	7	100	24
SHALLOW BOTTOMFISH	3636	27	5	96	29
Aprion virescens	1882	28	3	100	32
Epinephelus fasciatus	1612	28	2	100	35
Hipposcarus longiceps	1598	25	2	89	37
Mulloidichthys flavolineatus	1532	26	2	93	39
Naso lituratus	1529	28	2	100	42
Cheilinus undulatus	1089	25	2	89	43
Lethrinus harak	1069	26	2	93	45
Siganus spinus	1020	26	2	93	46
Lethrinus obsoletus	973	28	1	100	48
Caesio caerulaurea	972	16	1	57	49
Acanthurus lineatus	970	27	1	96	51
Lethrinus xanthochilus	955	28	1	100	52
Variola louti	947	28	1	100	54
Kyphosus cinerascens	939	28	1	100	55
Carcharhinus melanopterus	894	24	1	86	56
Chlorurus sordidus	853	28	1	100	58
Acanthurus triostegus triostegus	848	26	1	93	59
Scarus altipinnis	791	25	1	89	60
Lutjanus bohar	754	28	1	100	61
Chlorurus microrhinos	721	27	1	96	62
Scarus schlegeli	719	28	1	100	63
Carcharhinus amblyrhynchos	682	23	1	82	64
Lutjanus kasmira	674	28	1	100	65
Siganus argenteus	671	25	1	89	66
Lethrinus olivaceus	646	27	1	96	67
Kyphosus vaigiensis	544	27	1	96	68
Gerres acinaces	523	23	1	82	69
LETHRINIDAE	519	27	1	96	70
SCARIDAE	505	24	1	86	71
Scarus rubroviolaceus	475	23	1	82	71
Chlorurus frontalis	473	26	1	93	72
Epinephelus merra	470	28	1	100	73
Monotaxis grandoculus	468	25	1	89	73
Epinephelus octofasciatus	421	10	1	36	74
Scarus psittacus	405	27	1	96	75
Myripristis berndti	393	28	1	100	75
Sargocentron spiniferum	390	28	1	100	76
Parupeneus barberinus	373	25	1	89	76
Acanthurus xanthopterus	364	27	1	96	77
Plectropomus laevis	359	21	1	75	78
Cephalopholis sonnerati	345	28	1	100	78
Crenimugil crenilabis	344	20	1	71	79

Lutjanus fulvus	341	28	1	100	79
Carcharhinus galapagensis	322	7	0	25	80
Lutjanus monostigma	309	25	0	89	80
Triaenodon obesus	300	19	0	68	80
Ellochelon vaigiensis	297	26	0	93	81
Moolgarda engeli	294	24	0	86	81
Moolgarda seheli	267	22	0	79	82
Lutjanus gibbus	250	26	0	93	82
Gnathodentex aurolineatus	246	26	0	93	83
Parupeneus multifasciatus	245	27	0	96	83
Melichthys vidua	231	24	0	86	83
Aphareus furca	229	28	0	100	84
Lethrinus atkinsoni	225	25	0	89	84
Sargocentron tiere	223	28	0	100	84
Cheilinus trilobatus	221	26	0	93	85
Naso tonganus	218	22	0	79	85
Mulloidichthys ti'ao	211	26	0	93	85
Pterocaesio tile	210	13	0	46	86
Epinephelus polyphekadion	208	24	0	86	86
Siganus punctatus	201	26	0	93	86
Naso caesius	186	14	0	50	86
Diodon hystrix	182	19	0	68	87
Caranx papuensis	181	23	0	82	87
BALISTIDAE	180	24	0	86	87
Naso hexacanthus	177	23	0	82	88
Scarus forsteni	174	26	0	93	88
Lutjanus argentimaculatus	173	22	0	79	88
Parupeneus Insularis	171	27	0	96	88
SERRANIDAE	170	26	0	93	89
Ctenochaetus striatus	169	28	0	100	89
Acanthurus nigricauda	166	23	0	82	89
Mulloidichthys vanicolensis	165	24	0	86	89
Variola albimarginata	163	26	0	93	90
Cephalopholis argus	160	26	0	93	90
Gymnothorax javanicus	154	20	0	71	90
Xyrichtys pavo	154	28	0	100	90

Figure 3. Percentage contribution of each species/species groups to the total coral reef fish catch in Guam.

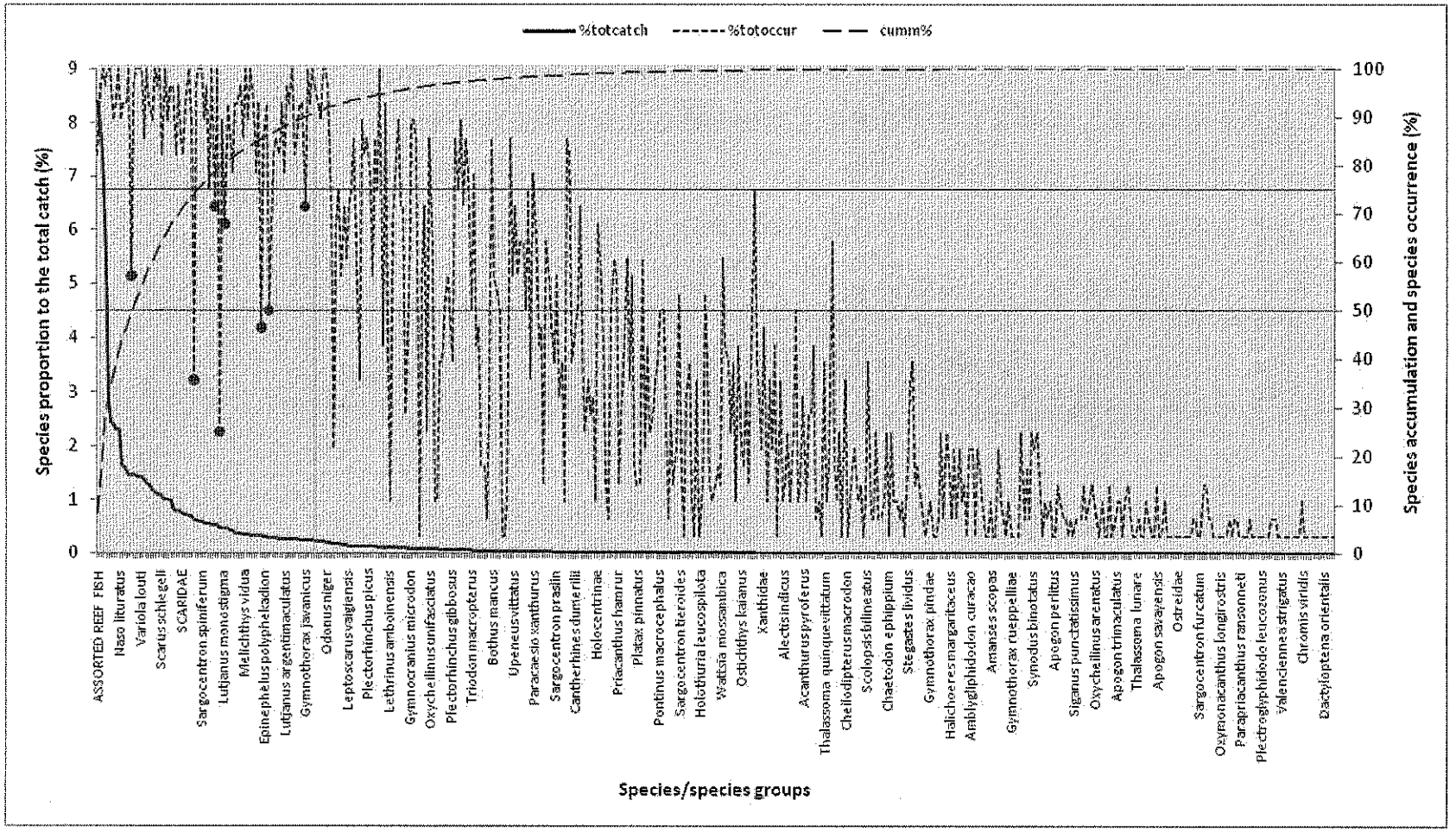
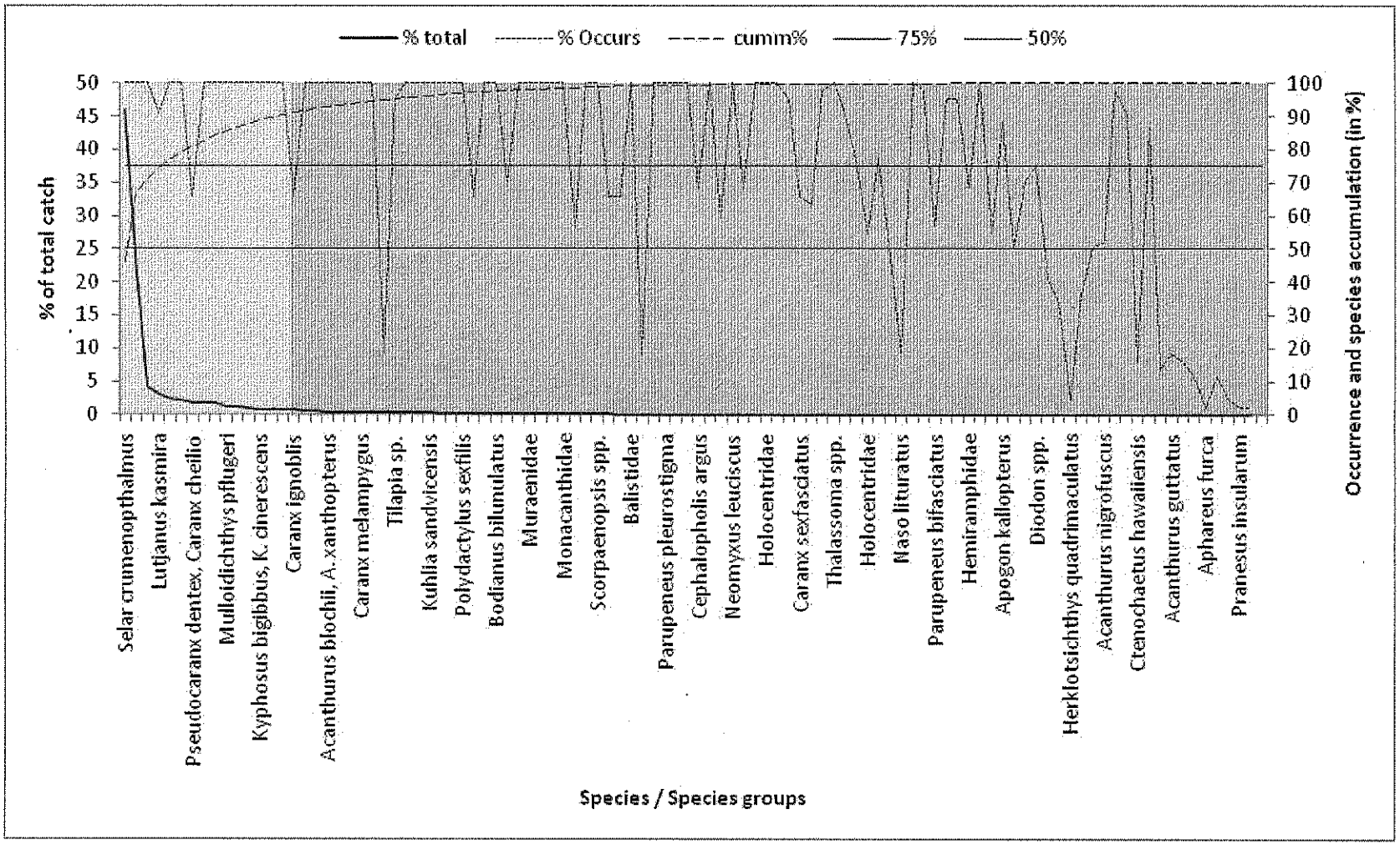


Table 8. Species and species groups that comprise the top 90% of the coral reef catch in Hawaii.

Scientific	Total	% total	% Occurs	Yrs Occur	cumm%
Selar crumenopthalmus	12,929,727	46.0	100	44	46.0
Decapterus macarellus	5,943,378	21.1	100	44	67.1
Carangidae	1,172,669	4.2	100	44	71.3
Lutjanus kasmira	837,212	3.0	91	40	74.3
Myripristis spp.	684,846	2.4	100	44	76.7
Mullidae	642,594	2.3	100	44	79.0
Pseudocaranx dentex, Caranx cheilio	505,264	1.8	66	29	80.8
Scarus spp.	497,405	1.8	100	44	82.6
Acanthurus dussumieri	482,132	1.7	100	44	84.3
Mulloidichthys pflugeri	363,979	1.3	100	44	85.6
Naso annulatus, brevirostris, unicornis	335,443	1.2	100	44	86.8
Albula glossodonta	303,024	1.1	100	44	87.8
Kyphosus bigibbus, K. cinerescens	252,570	0.9	100	44	88.7
Mugil cephalus	231,017	0.8	100	44	89.6
Acanthurus triostegus	220,865	0.8	100	44	90.3

Figure 4. Percentage contribution of each species/species groups to the total coral reef fish catch in Hawaii.



Time series of annual mean length from catch data of species comprising the top 90% of the coral reef fishery catch

1. American Samoa
2. Commonwealth of Northern Mariana Islands
3. Guam
4. Hawaii

Figure 5. Temporal trend in lengths of species that comprise 90% of the total coral reef catch in American Samoa from boat and shore catches

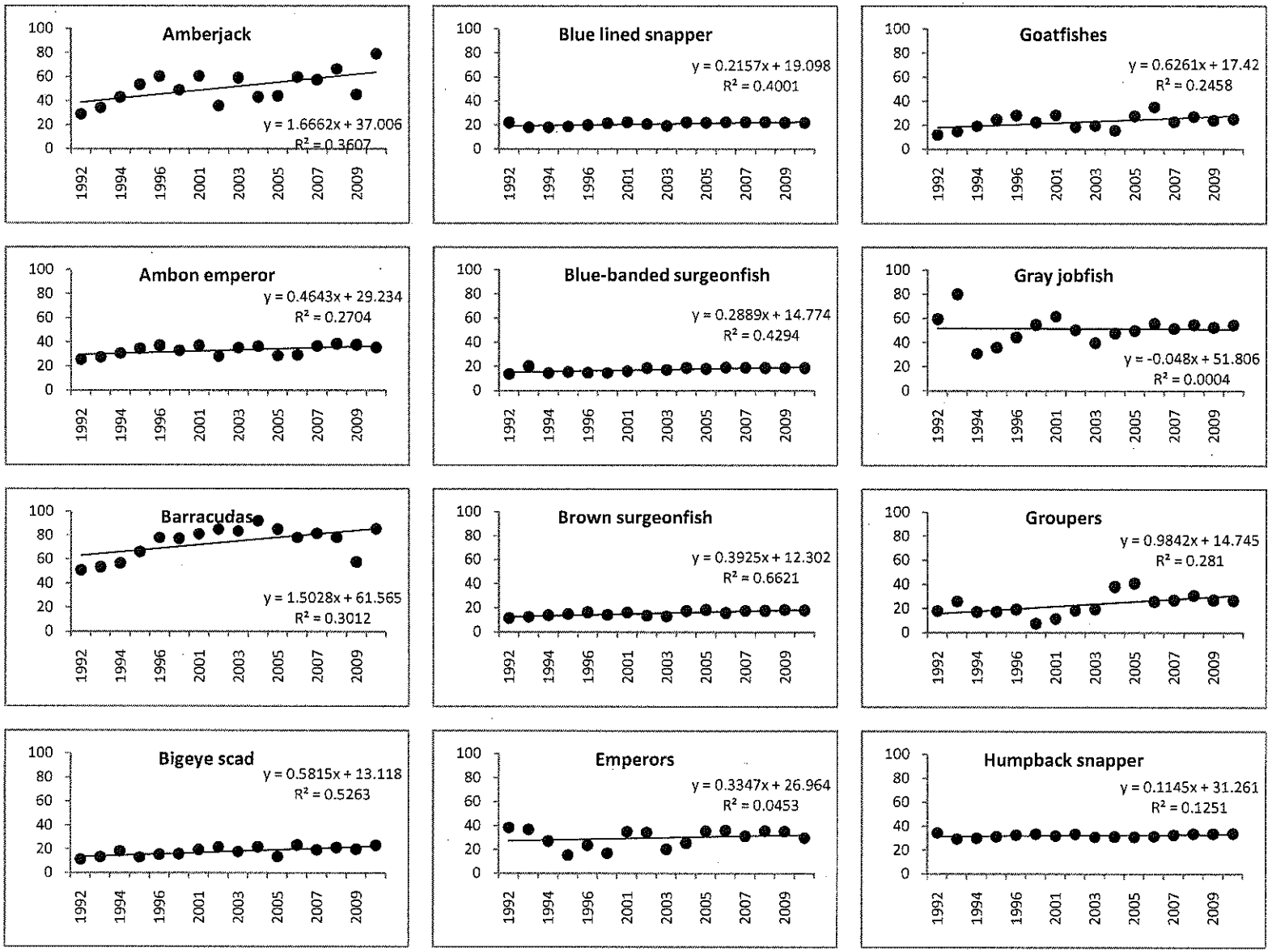


Figure 5. Continued 2/3

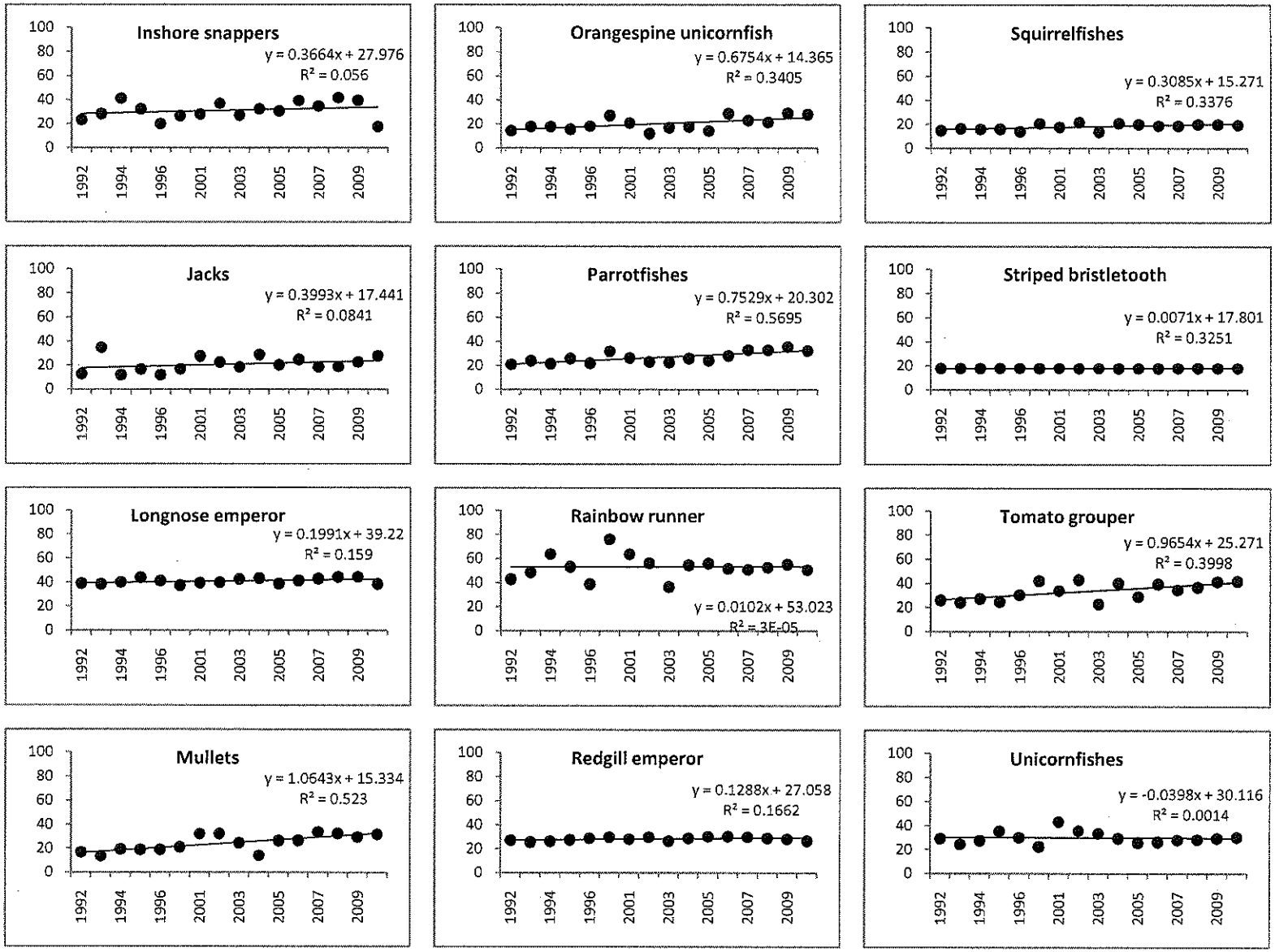


Figure 5. Continued 2/3

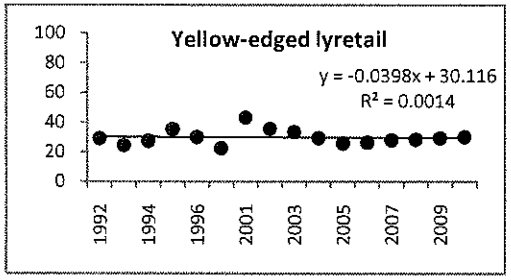


Figure 6. Temporal trend in lengths of species that comprise 90% of the total coral reef catch in CNMI from boat and shore catches

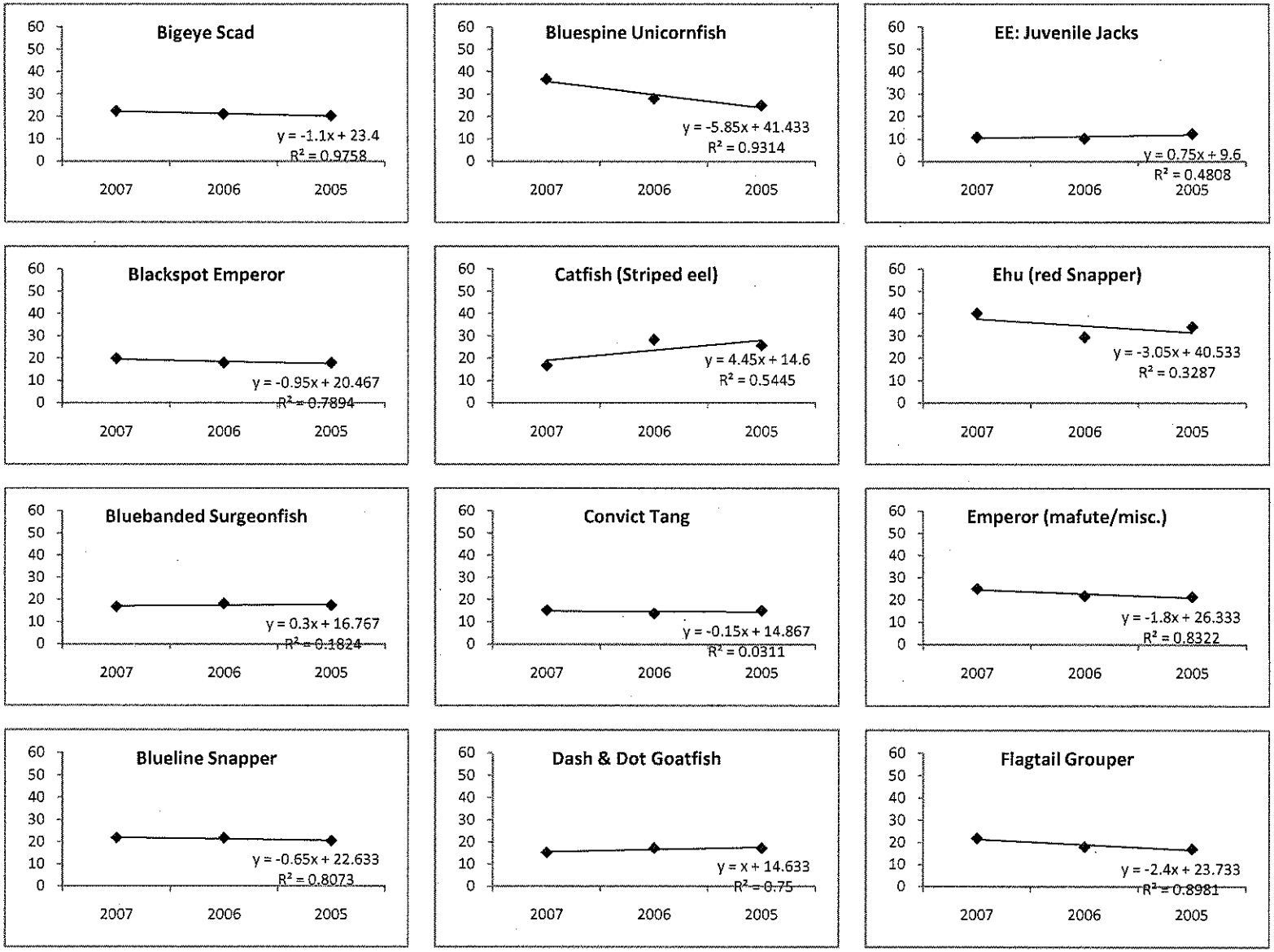


Figure 6. Continued 2/5

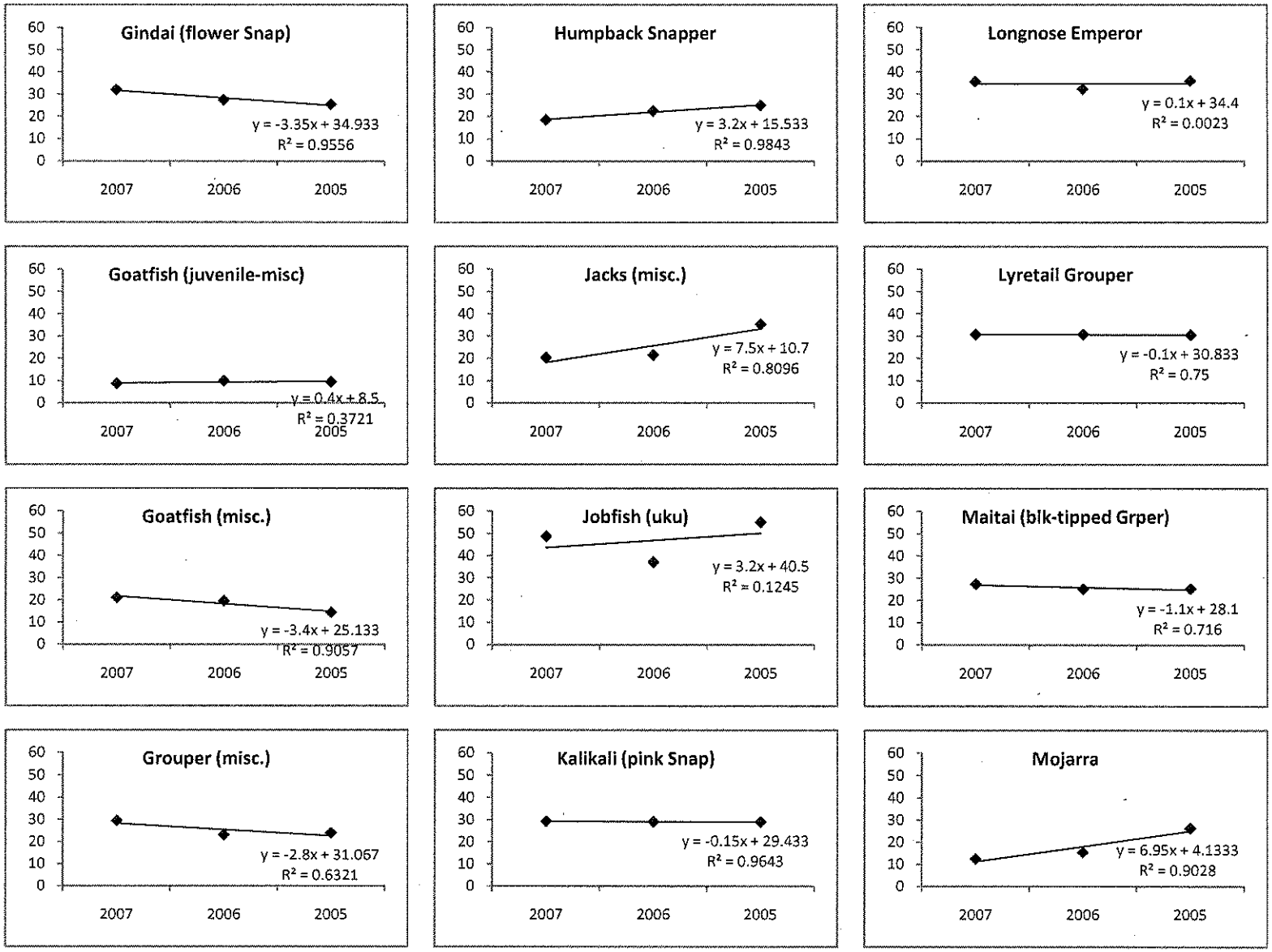


Figure 6. Continued 3/5

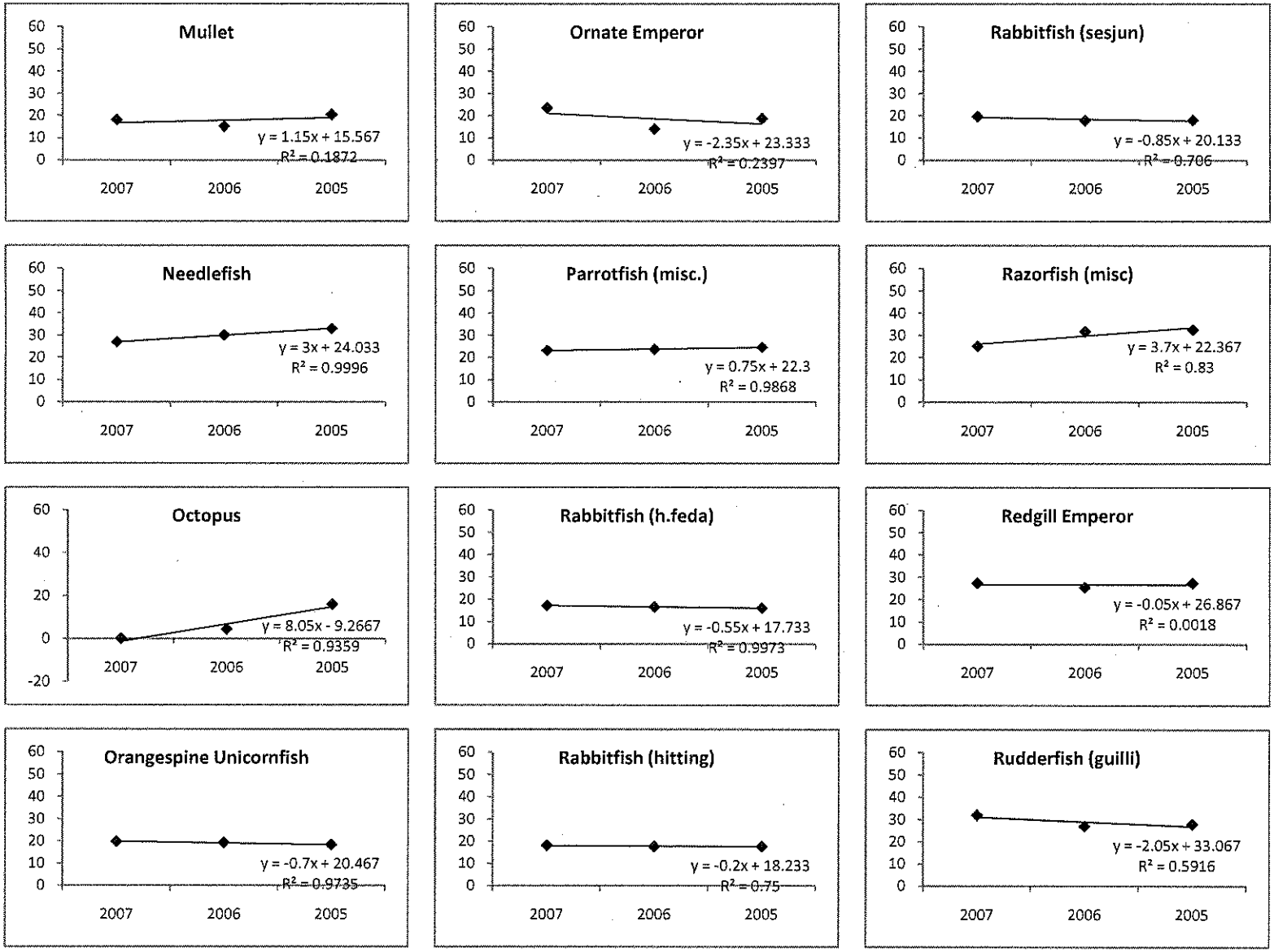


Figure 6. Continued 4/5

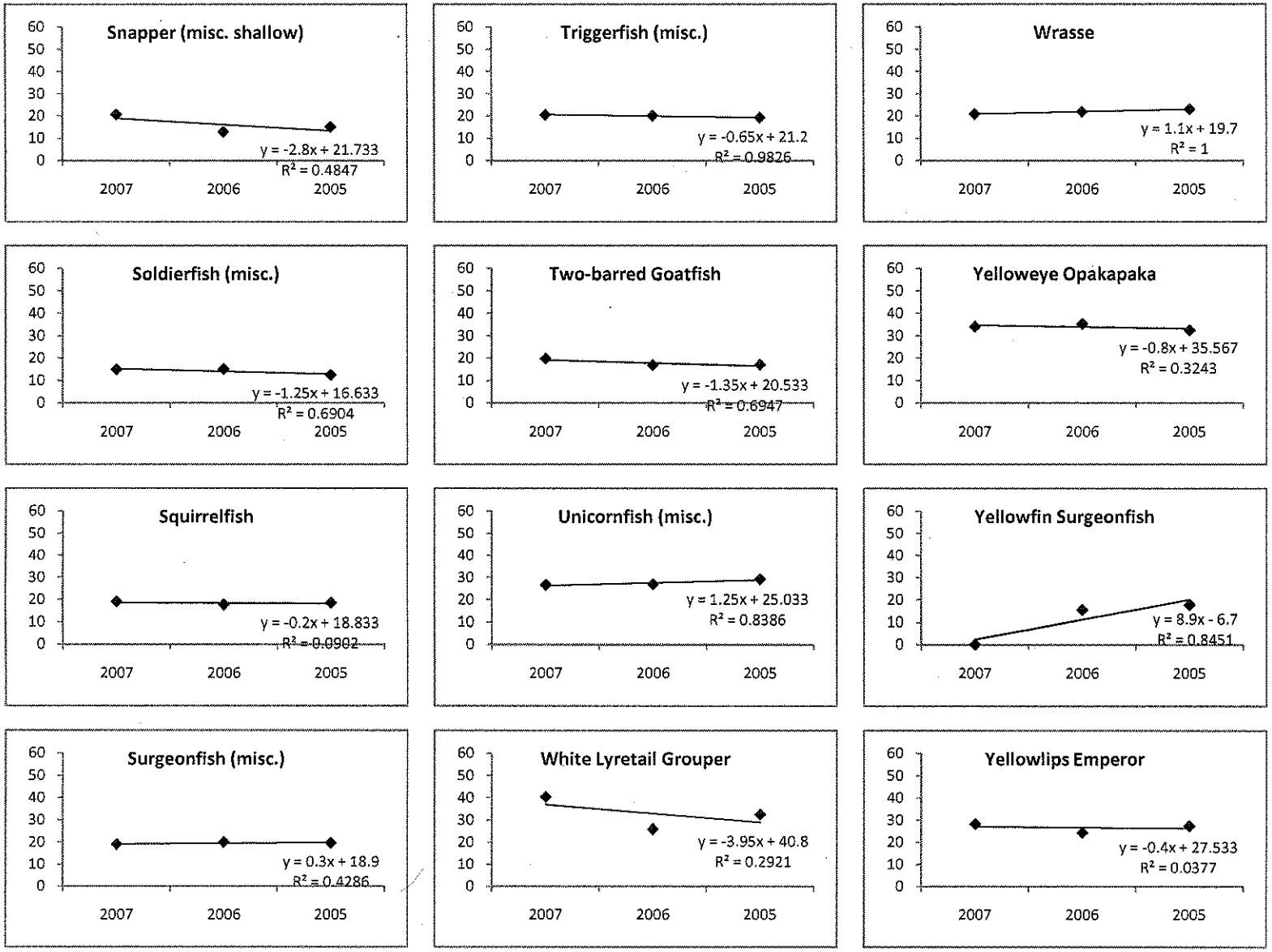
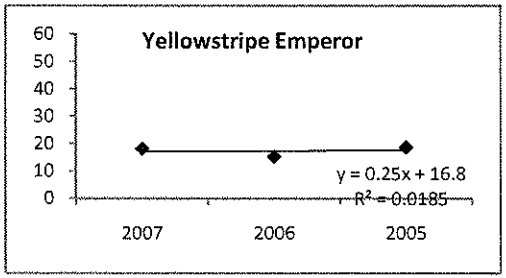


Figure 6. Continued 5/5



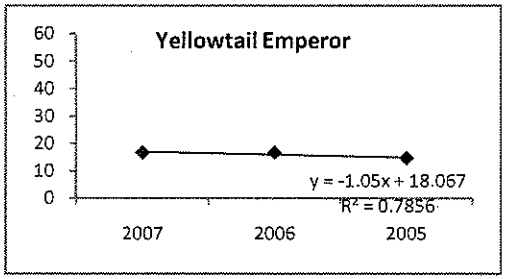


Figure 7. Temporal trend in lengths of species that comprise 90% of the total coral reef catch in Guam from boat and shore catches

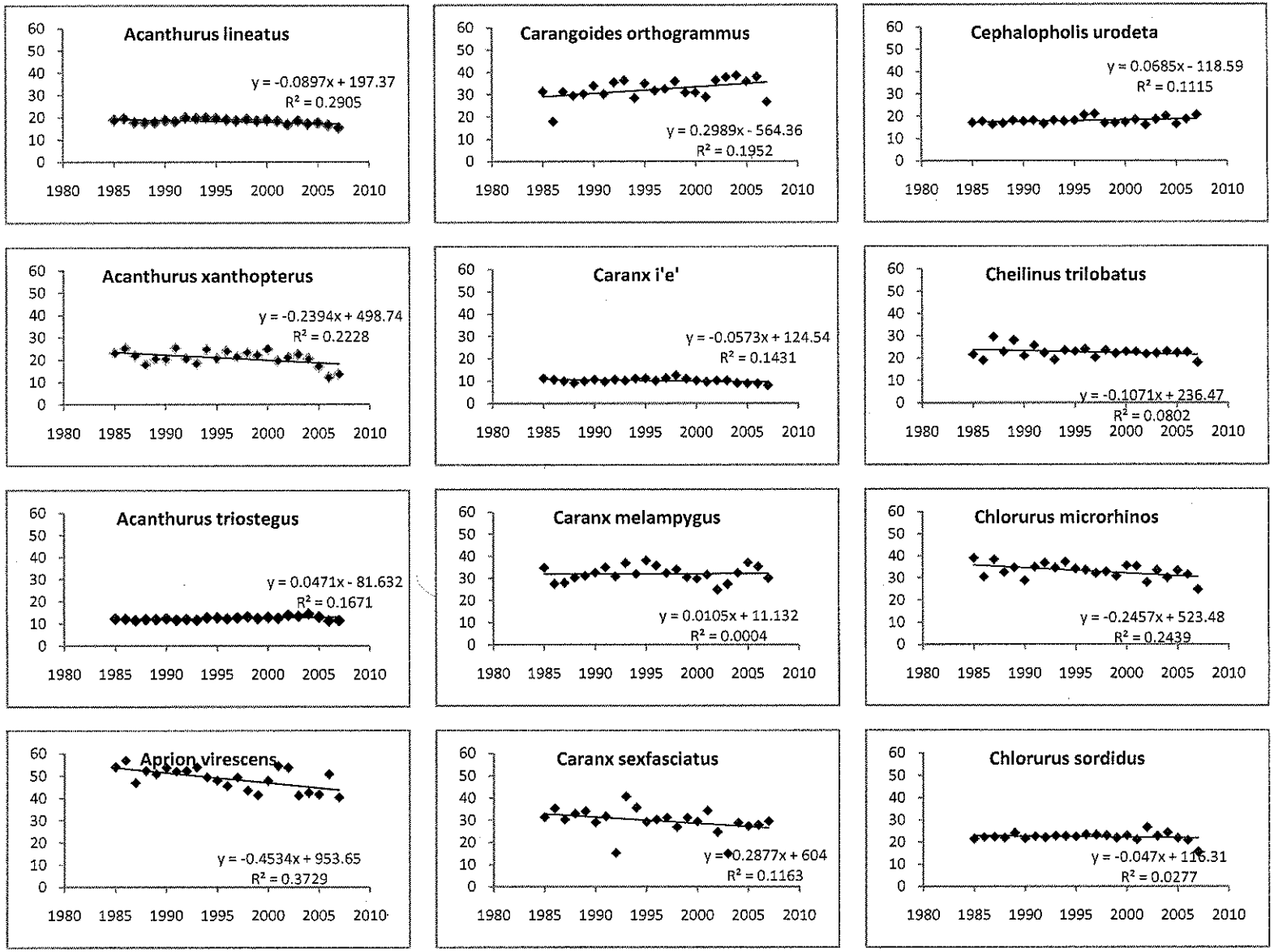


Figure 7. Continued 2/5

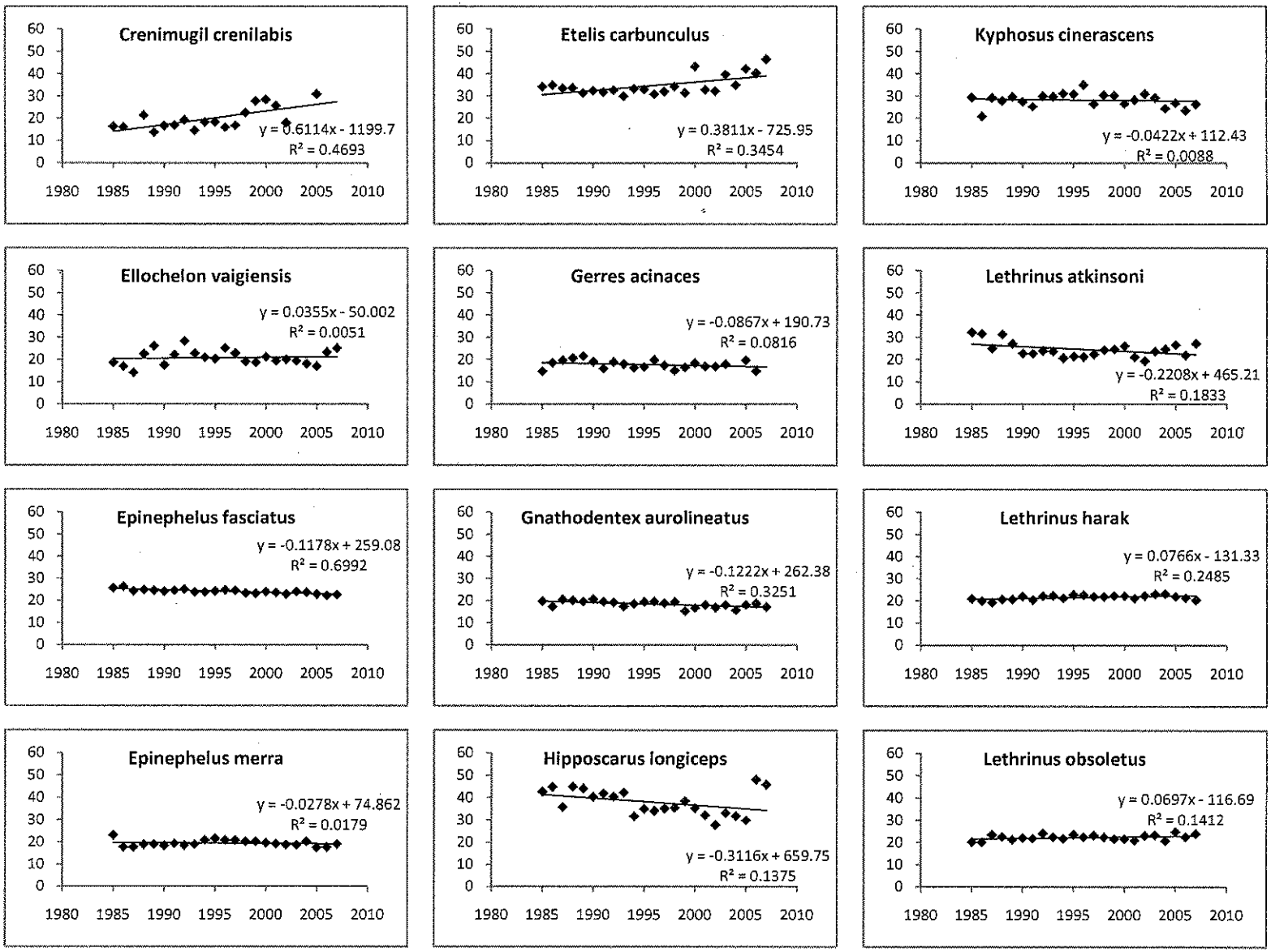


Figure 7. Continued 3/5

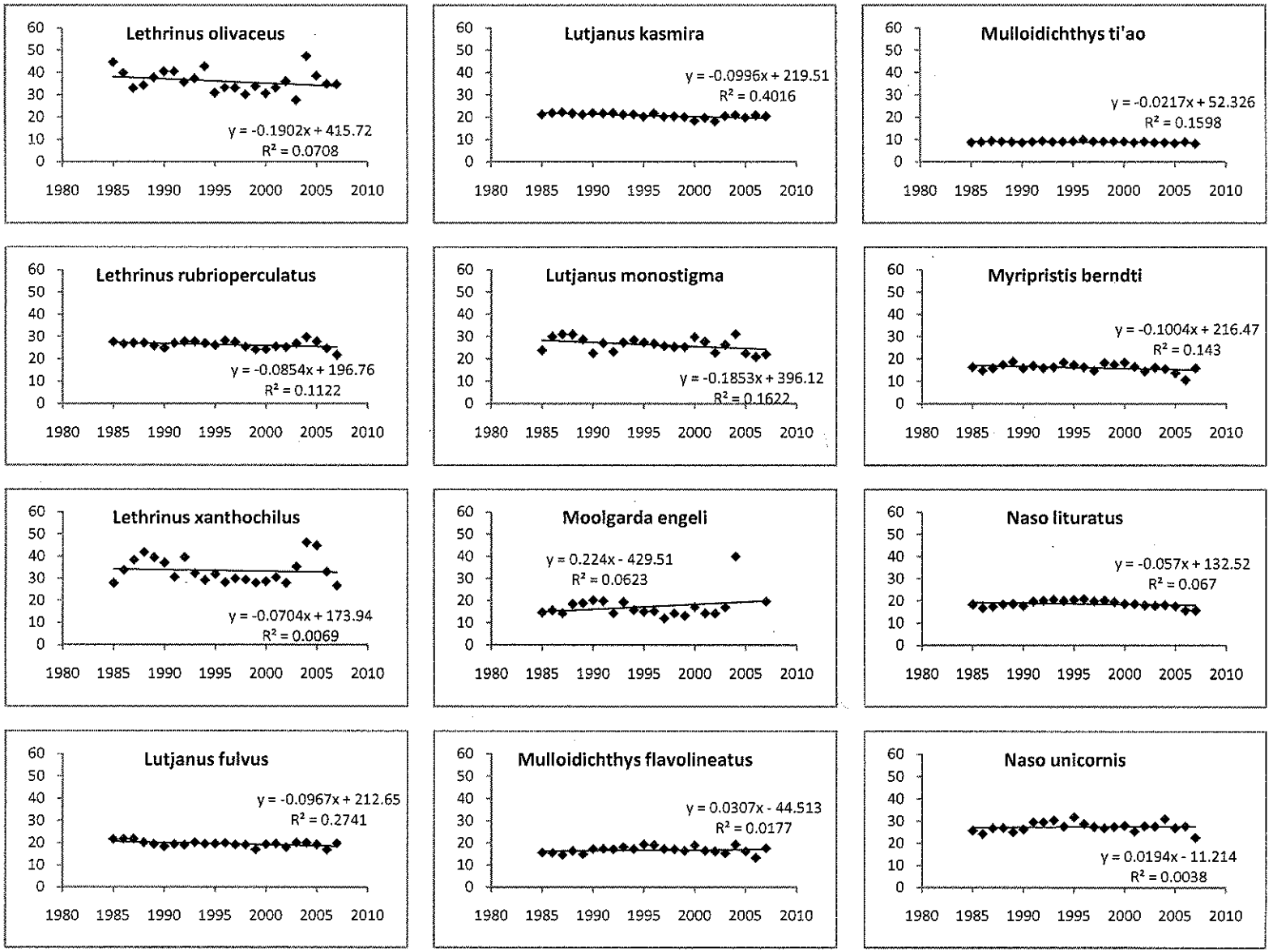


Figure 7. Continued 4/5

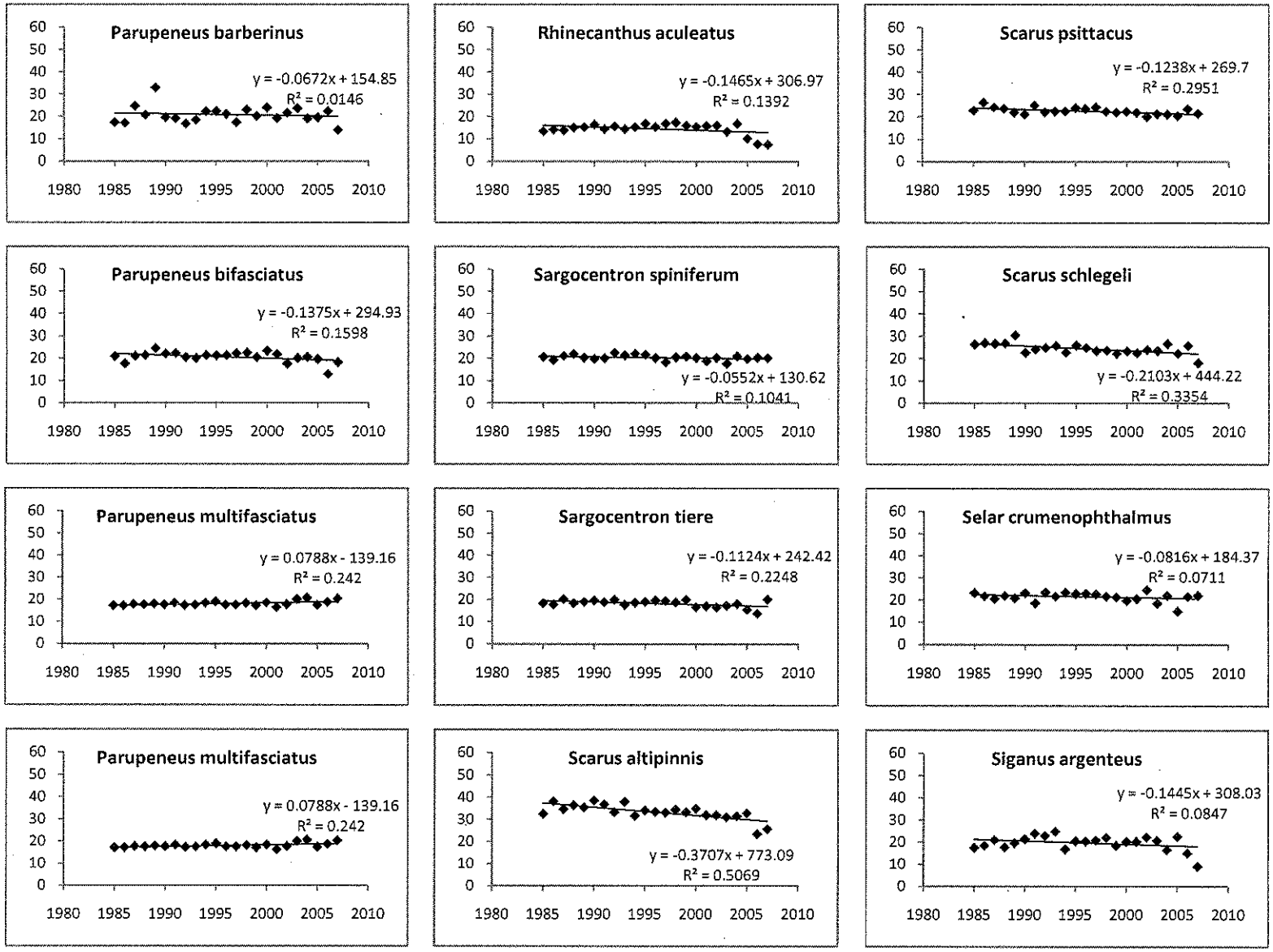
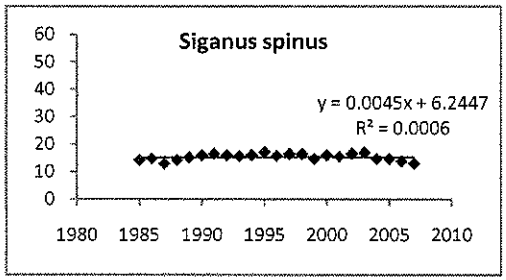
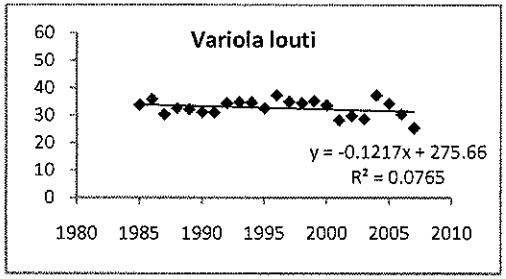
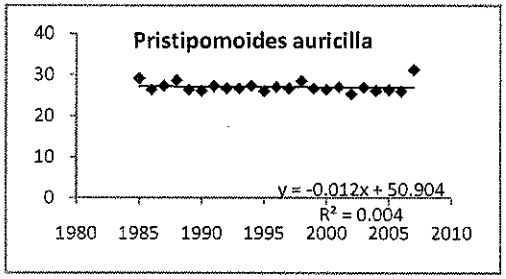
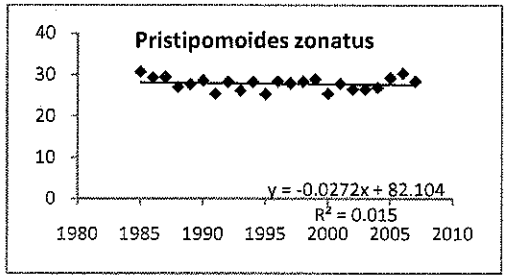


Figure 7. Continued 5/5









Time series of annual mean length from underwater census survey data of species comprising the top 90% of the coral reef fishery catch

1. American Samoa
2. Northern Mariana Islands (Guam and CNMI)

Figure 8. Temporal trend in lengths of species that comprise 90% of the total coral reef catch in American Samoa from underwater visual census surveys

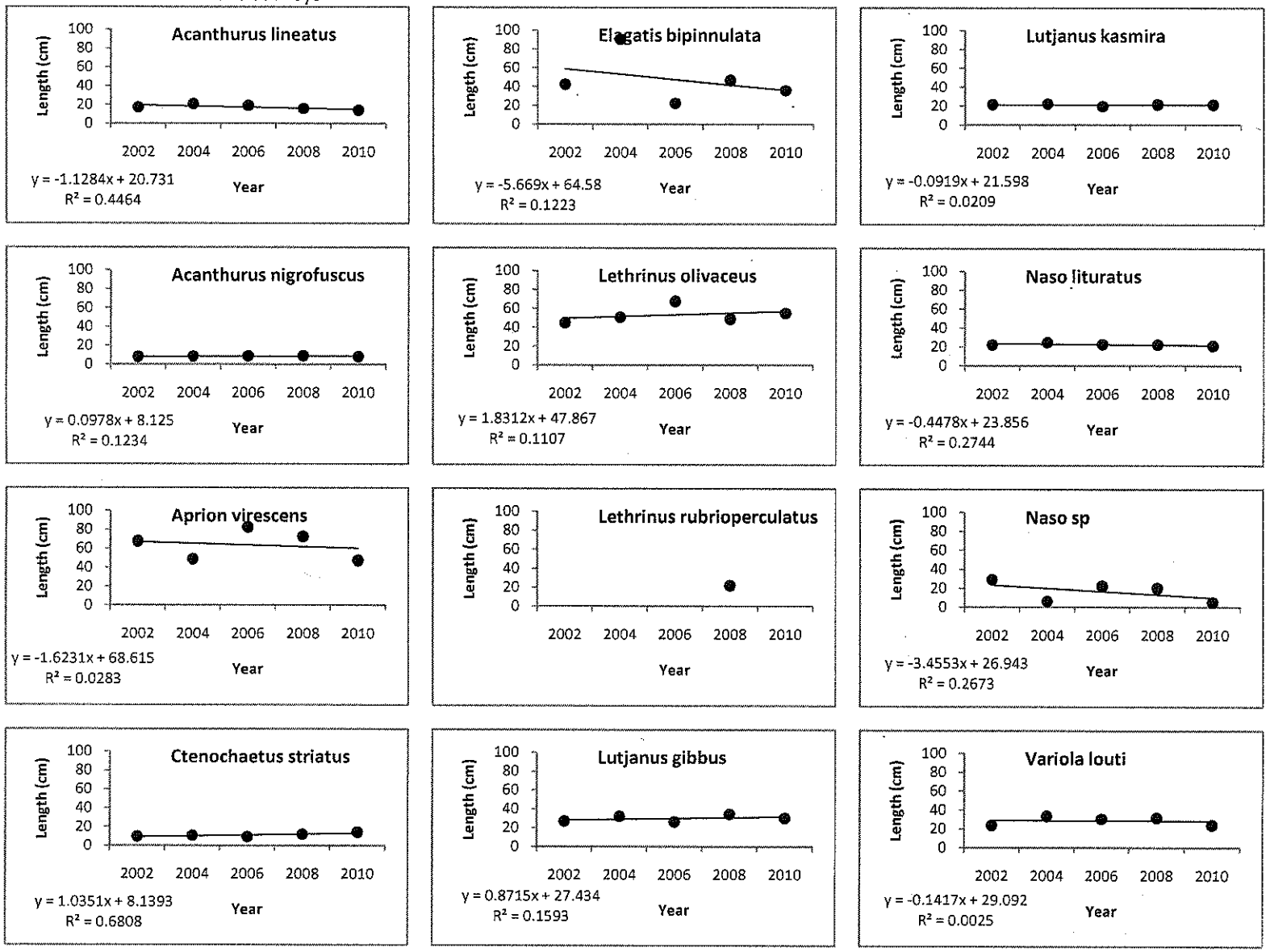


Figure 8. Continued 2/2

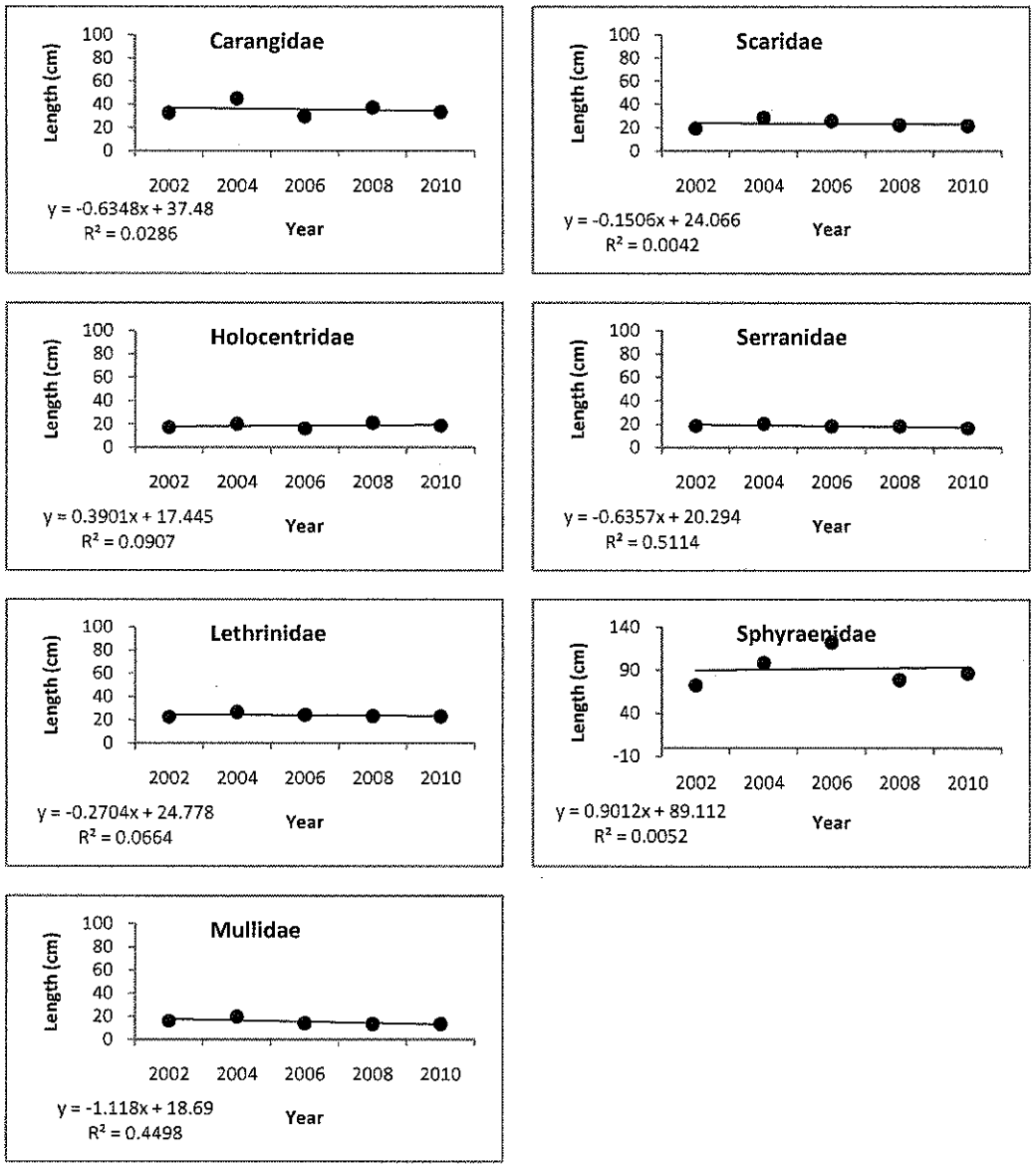


Figure 9. Temporal trend in lengths of species that comprise 90% of the total coral reef catch in the Nortern Mariana Islands from underwater visual census

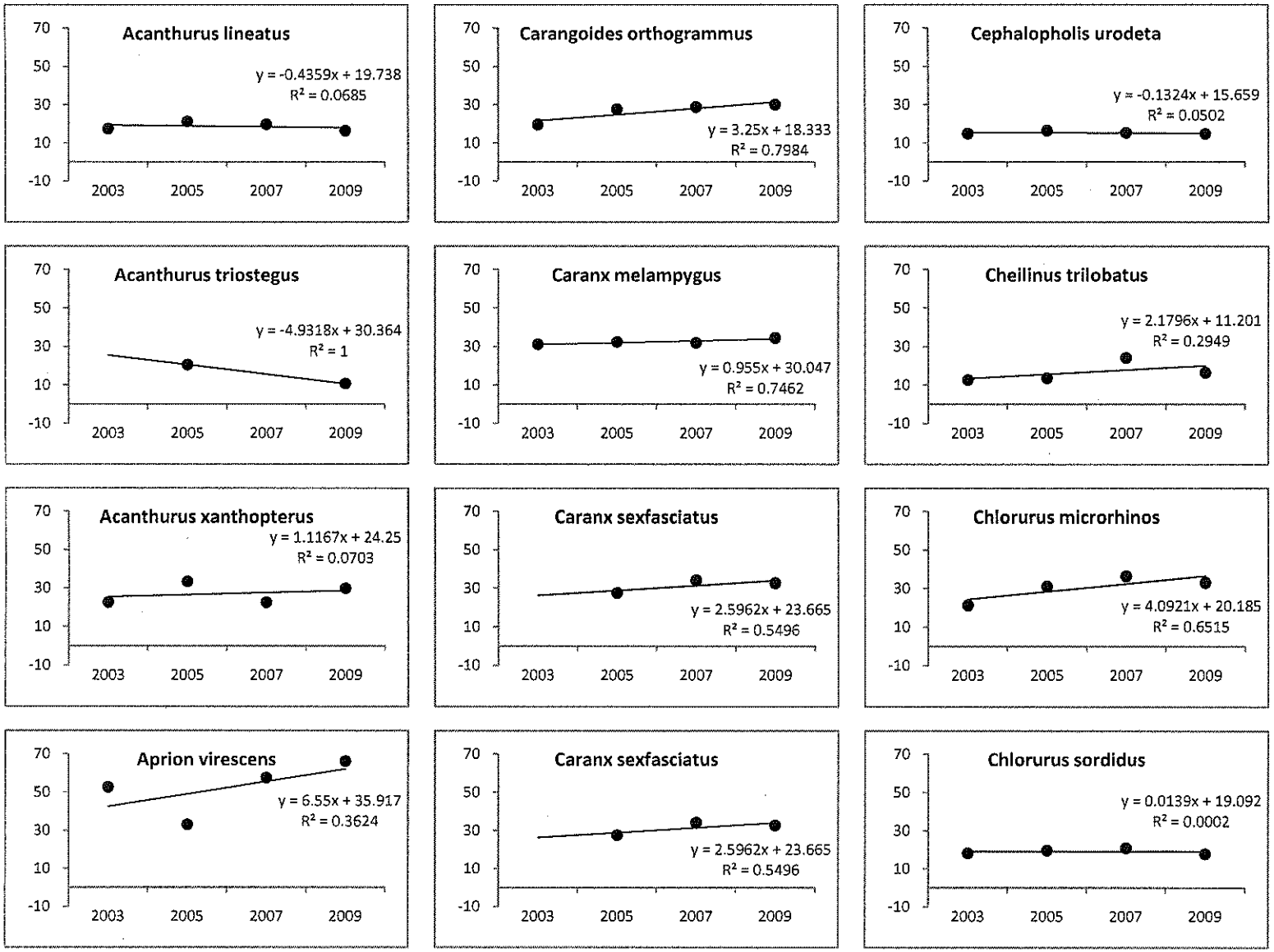


Figure 9. Continued 2/4

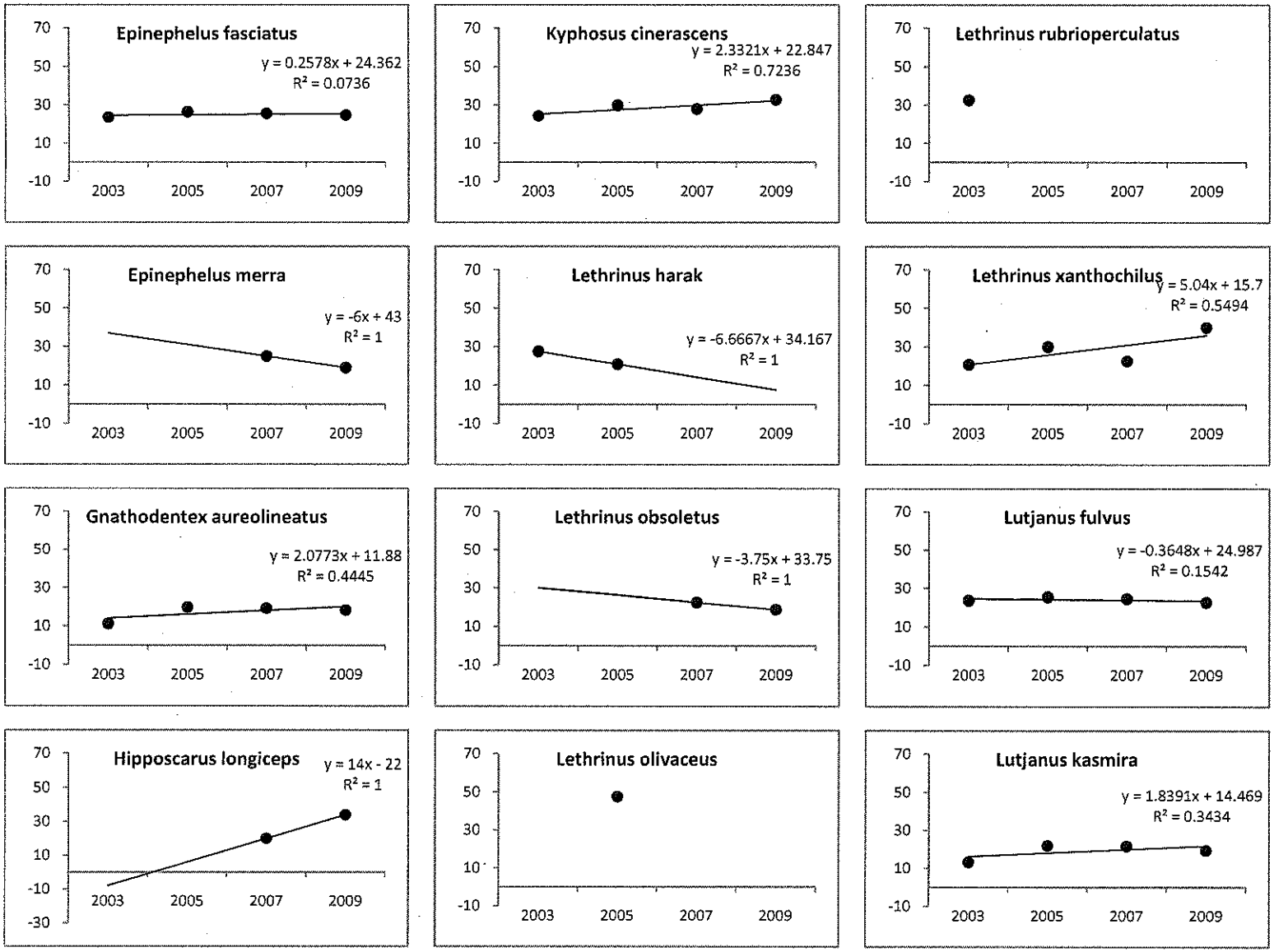


Figure 9. Continued 3/4

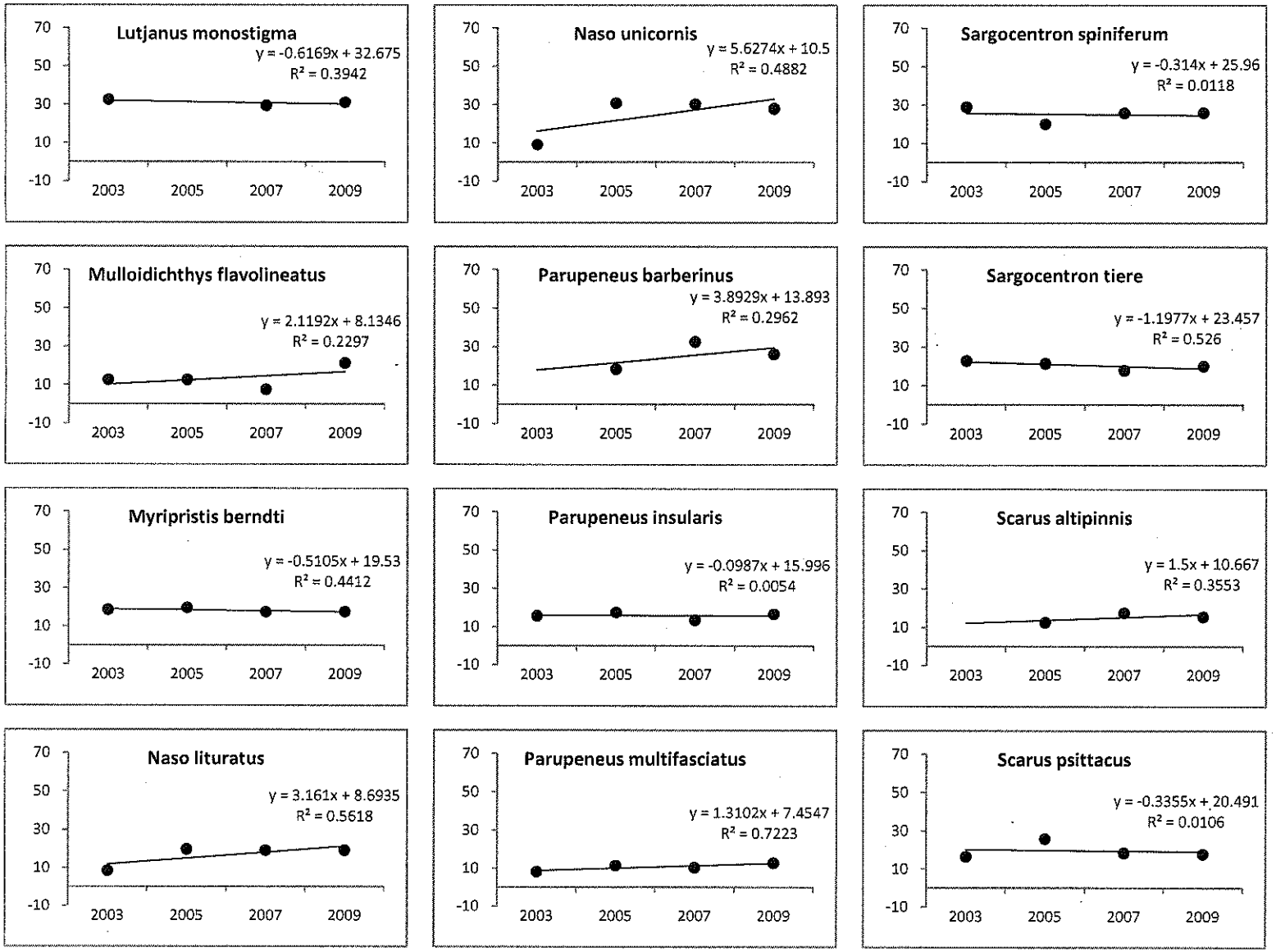
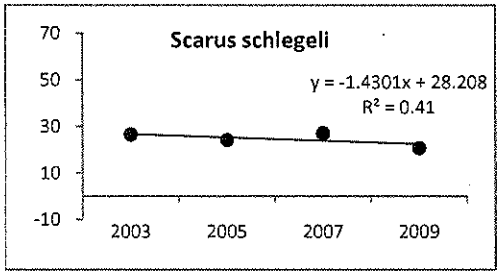
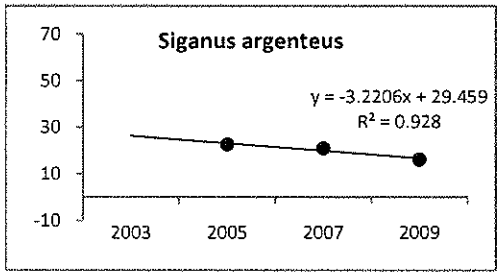
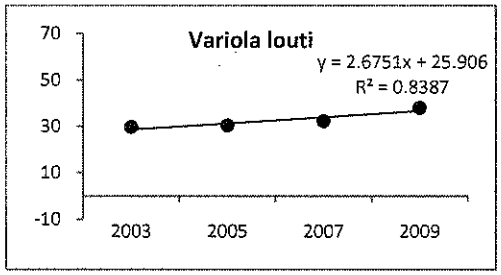


Figure 9. Continued 4/4







Size frequency distributions of species comprising the top 90% of the coral reef fishery catch

1. American Samoa
2. Commonwealth of Northern Mariana Islands

Figure 10. Species size frequency distribution of the species comprising the top 90% of the coral reef catches in the American Samoa. The data was from the boat-based and shore-based catches and underwater visual census surveys of NOAA PIFSC CRED.

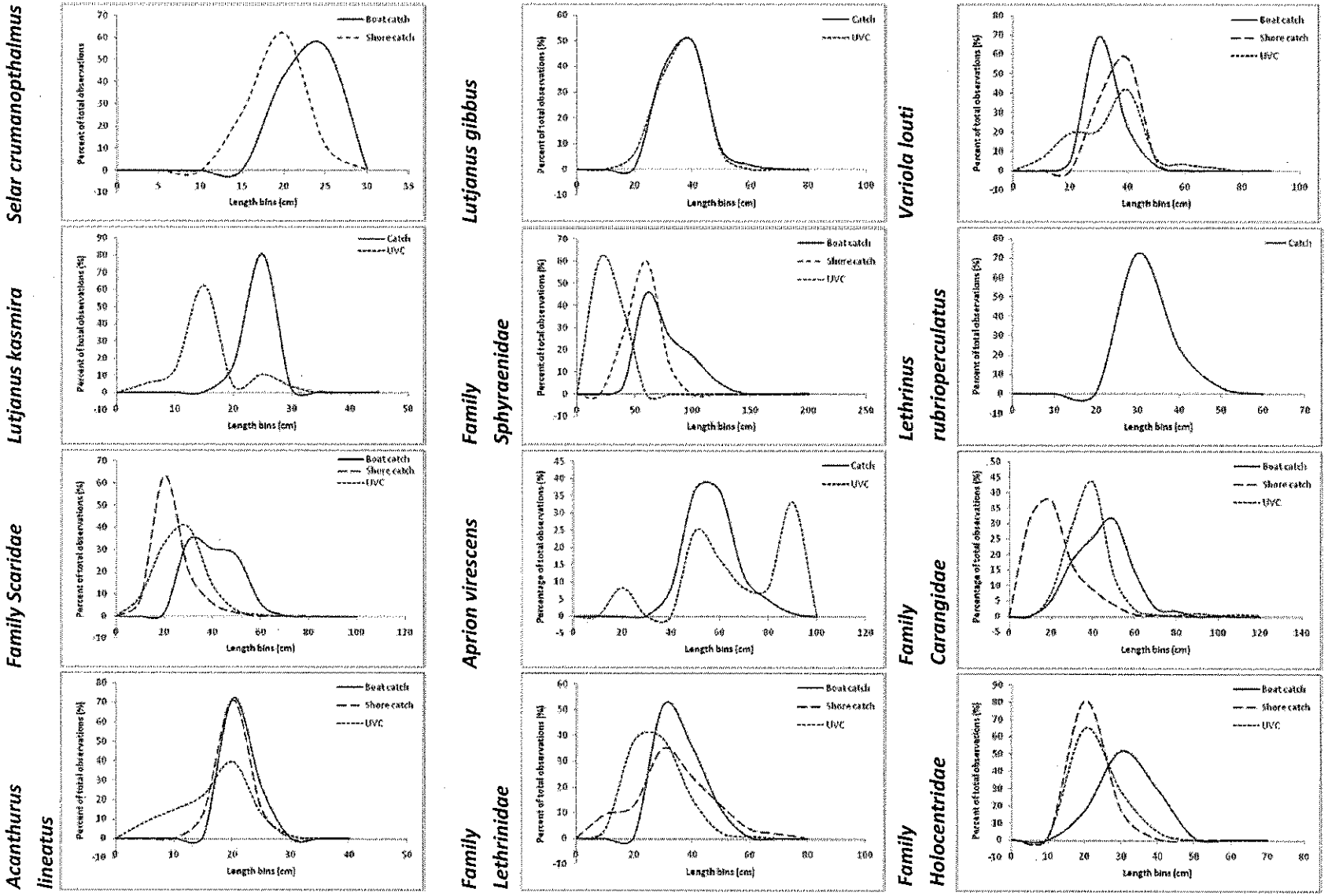


Figure 10. Continued 2/2

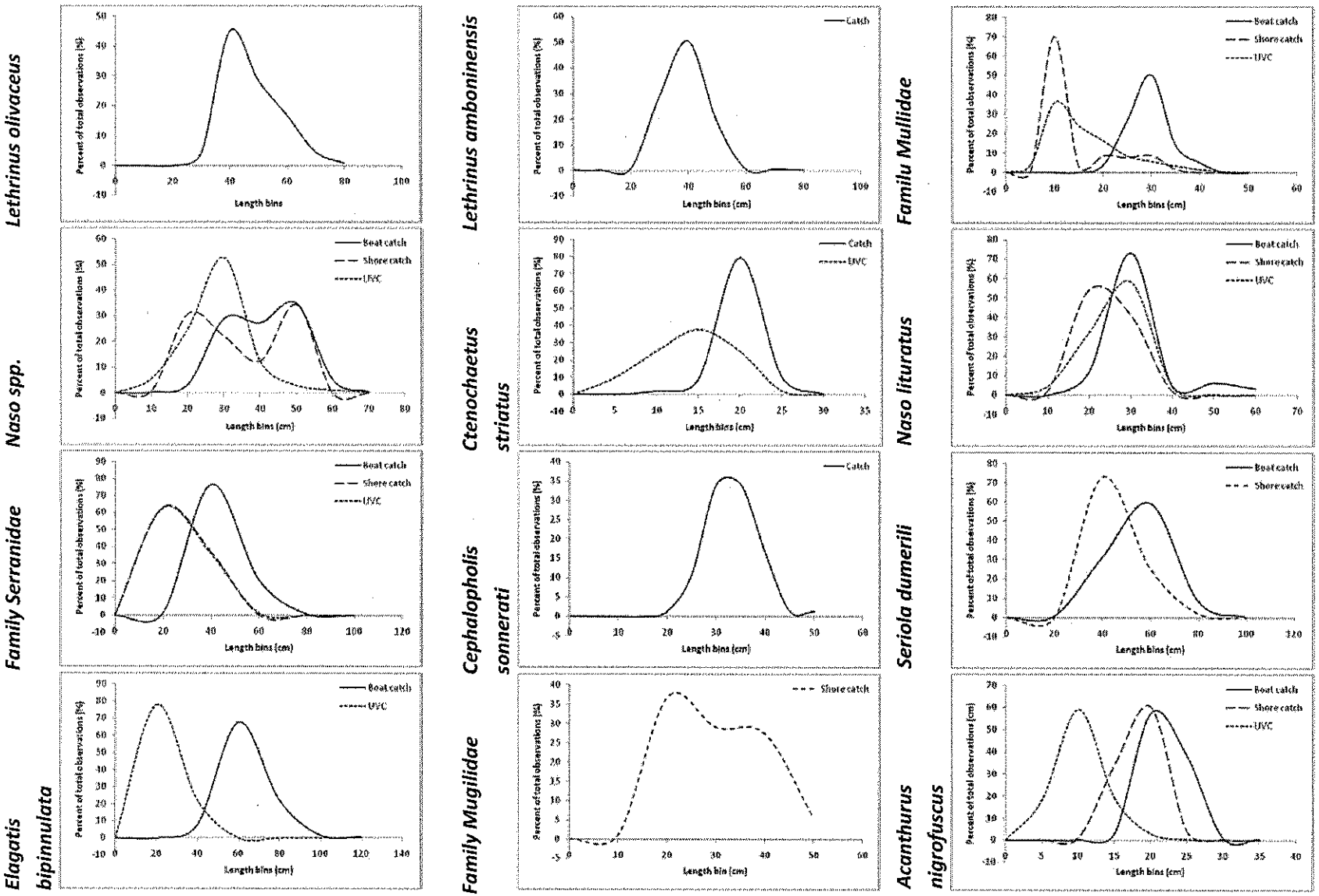


Figure11. Species size frequency distribution of the species comprising the top 90% of the coral reef catches in the Northern Mariana Islands. The data was from the boat-based and shore-based catches and underwater visual census surveys of NOAA PIFSC CRED.

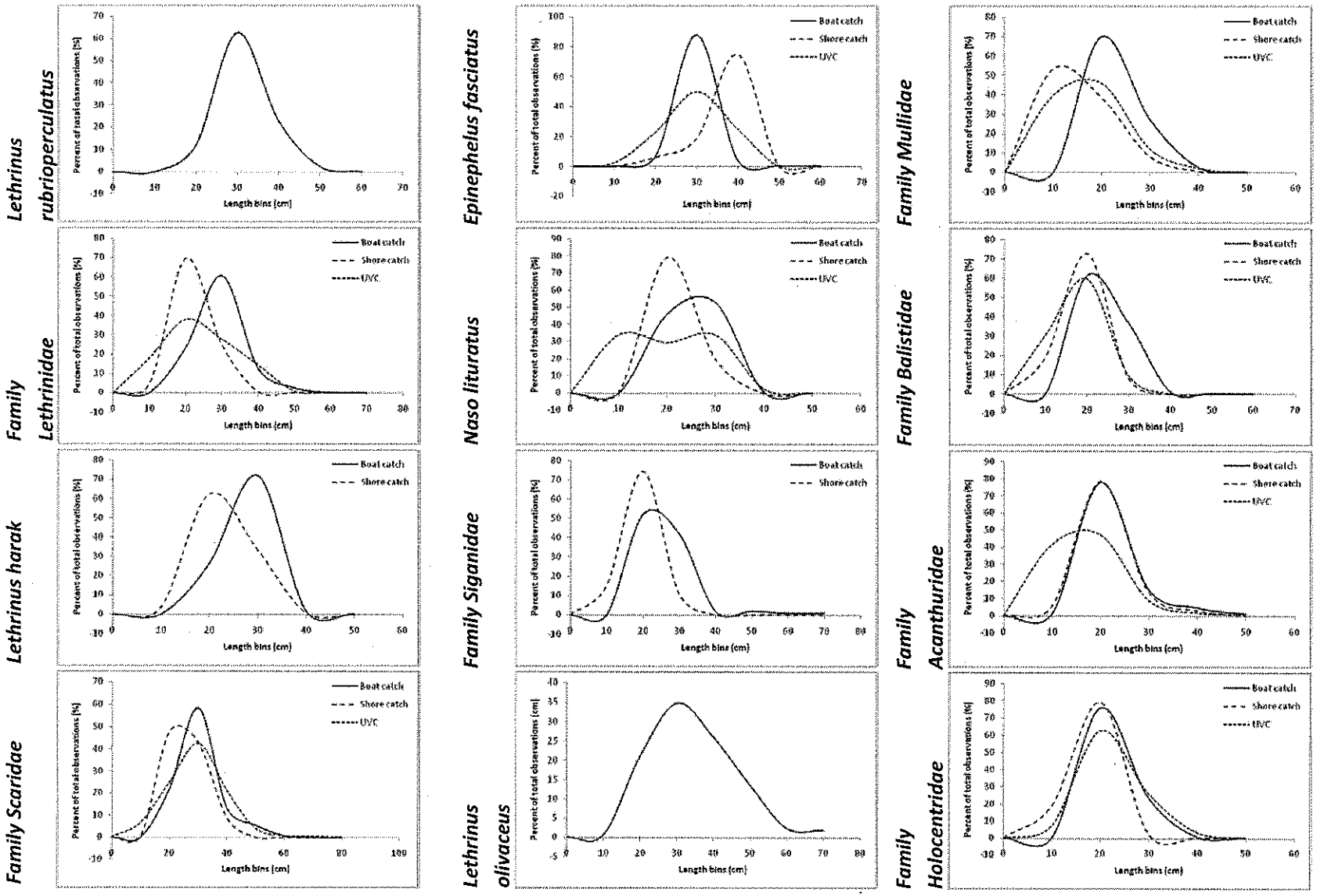


Figure 11. Continued 2/3

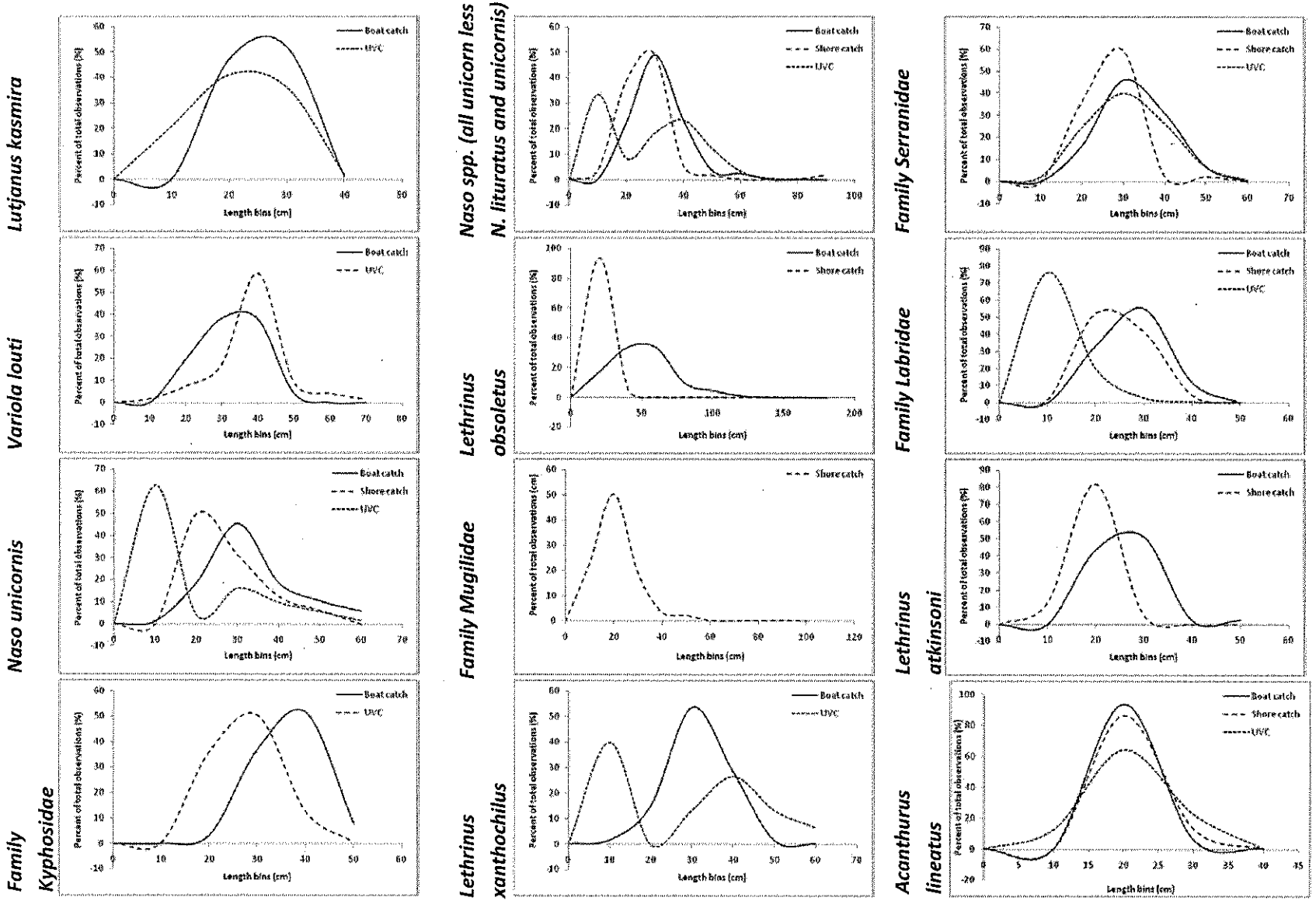
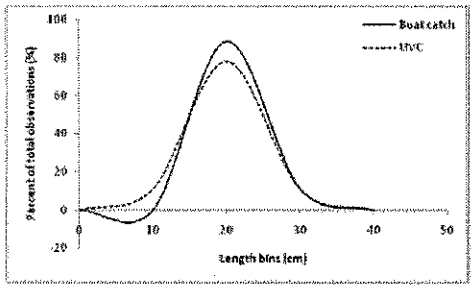
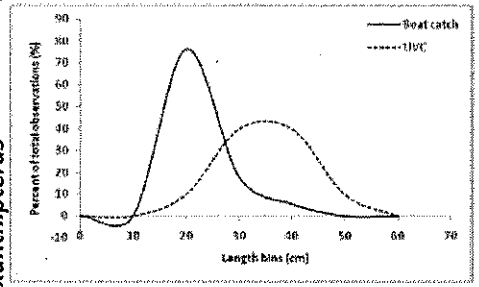


Figure 11. Continued 3/3

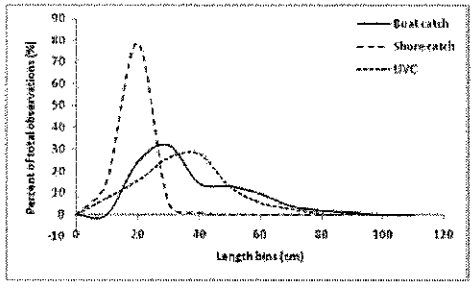
Cephalopholis urodeta



Acanthurus xanthipterus



Family Lutjanidae



Regression analysis of the time series of fish lengths (test of significance)

1. American Samoa
2. Northern Mariana Islands (Guam and CNMI)

Table 9. Regression trends and significance of fish sizes over time of the species comprising the coral reef catches in American Samoa

Species	Catch data					UVC data					Pattern interpretation
	R	R^2	SE	F_{stat}	P	R	R^2	SE	F_{stat}	P	
Amberjack	0.60	0.36	10.93	7.90	0.01						
Ambon emperor	0.52	0.27	3.76	5.19	0.04						
Barracudas	0.55	0.30	11.28	6.03	0.03	0.07	0.01	22.70	0.02	0.91	Enhanced harvest with no impact to population
Bigeye scad	0.73	0.53	2.72	15.55	0.00						
Blue lined snapper	0.63	0.40	1.30	9.34	0.01	0.14	0.02	1.15	0.06	0.82	Enhanced harvest with no impact to population
Blue-banded surgeonfish	0.66	0.43	1.64	10.54	0.01	0.67	0.45	2.29	2.42	0.22	Enhanced harvest with no impact to population
Brown surgeonfish	0.81	0.66	1.38	27.43	0.00	0.35	0.12	0.48	0.42	0.56	Enhanced harvest with no impact to population
Emperors	0.21	0.05	7.57	0.66	0.43	0.26	0.07	1.85	0.21	0.68	No change in population
Goatfishes	0.50	0.25	5.41	4.56	0.05	0.67	0.45	2.26	2.45	0.22	Enhanced harvest with no impact to population
Gray jobfish	0.02	0.00	11.66	0.01	0.94	0.17	0.03	17.37	0.09	0.79	
Groupers	0.53	0.28	7.76	5.47	0.03	0.72	0.51	1.13	3.14	0.17	Enhanced harvest with no impact to population
Humpback snapper	0.35	0.13	1.49	2.00	0.18	0.40	0.16	3.65	0.57	0.51	No change in population
Inshore snappers	0.24	0.06	7.41	0.83	0.38						
Jacks	0.29	0.08	6.49	1.29	0.28	0.17	0.03	6.75	0.09	0.79	No change in population
Longnose emperor	0.40	0.16	2.26	2.65	0.13	0.33	0.11	9.48	0.37	0.58	No change in population
Mullets	0.72	0.52	5.01	15.35	0.00						
Orangespine unicornfish	0.58	0.34	4.63	7.23	0.02	0.52	0.27	1.33	1.13	0.36	Enhanced harvest with no impact to population
Parrotfishes	0.75	0.57	3.23	18.52	0.00	0.07	0.00	4.22	0.01	0.92	Enhanced harvest with no impact to population
Rainbow runner	0.01	0.00	9.97	0.00	0.99	0.35	0.12	27.73	0.42	0.56	No change in population
Redgill emperor	0.41	0.17	1.42	2.79	0.12						
Squirrelfishes	0.58	0.34	2.13	7.14	0.02	0.30	0.09	2.26	0.30	0.62	Enhanced harvest with no impact to population
Striped bristletooth	0.57	0.33	0.05	6.74	0.02	0.83	0.68	1.29	6.40	0.09	Enhanced harvest with no impact to population
Tomato grouper	0.34	0.12	0.98	1.82	0.20						
Unicornfishes	0.63	0.40	5.83	9.33	0.01	0.52	0.27	10.44	1.09	0.37	
Yellow-edged lyretail	0.04	0.00	5.19	0.02	0.89	0.05	0.00	5.20	0.01	0.94	

Trend interpretation		
Catch	UVC	Enhanced harvest & population recovery/improving
Catch	UVC	Larger individuals harvested & population recruiting
Catch	UVC	Smaller individuals harvested & increasing adult population
Catch	UVC	No change in fished population w/ recruitment ongoing
Catch	UVC	Smaller individuals harvested & no change in population
Catch	UVC	No change in population
Catch	UVC	Enhanced harvest with no impact to population
Catch	UVC	Sustainable harvest & population recovering/improving
Catch	UVC	Population/stock is being impacted by fishing

Table 10. Regression trends and significance of fish sizes over time of the species comprising the coral reef catches in the Northern Mariana Islands

Species	Catch data					UVC data					Pattern interpretation
	R	R^2	SE	F_{stat}	P	R	R^2	SE	F_{stat}	P	
Acanthurus lineatus	0.55	0.30	0.02	8.89	0.007	0.27	0.07	0.06	0.16	0.727	Smaller individuals harvested & no change in population
Acanthurus triostegus	0.40	0.16	0.03	3.94	0.060						
Acanthurus xanthopterus	0.49	0.24	0.07	6.58	0.018	0.29	0.09	0.10	0.19	0.708	Smaller individuals harvested & no change in population
Aprion virescens	0.62	0.38	0.04	12.79	0.002	0.54	0.29	0.14	0.80	0.465	Smaller individuals harvested & no change in population
Carangoides orthogrammus	0.42	0.18	0.07	4.60	0.044	0.88	0.77	0.05	6.65	0.123	Smaller individuals harvested & no change in population
Caranx i'e'	0.41	0.16	0.04	4.13	0.055						
Caranx melampygus	0.01	0.00	0.05	0.00	0.958	0.87	0.75	0.01	5.99	0.134	No change in population
Caranx sexfasciatus	0.29	0.09	0.10	1.97	0.175	0.48	0.23	0.04	0.59	0.523	No change in population
Cephalopholis urodeta	0.33	0.11	0.03	2.52	0.127	0.22	0.05	0.03	0.10	0.777	No change in population
Cheilinus trilobatus	0.26	0.07	0.05	1.54	0.228	0.61	0.37	0.12	1.16	0.394	No change in population
Chlorurus microrhinos	0.49	0.24	0.04	6.55	0.018	0.81	0.66	0.07	3.86	0.188	Smaller individuals harvested & no change in population
Chlorurus sordidus	0.21	0.04	0.04	0.94	0.343	0.00	0.00	0.04	0.00	0.999	No change in population
Crenimugil crenilabis											
Ellochelon vaigiensis	0.10	0.01	0.07	0.23	0.638						
Epinephelus fasciatus	0.84	0.70	0.01	49.55	0.000	0.29	0.08	0.03	0.18	0.713	Smaller individuals harvested & no change in population
Epinephelus merra	0.12	0.01	0.03	0.30	0.588						
Etelis carbunculus	0.58	0.34	0.04	10.66	0.004						
Gerres acinaces											
Gnathodentex aurolineatus	0.56	0.31	0.03	9.51	0.005	0.69	0.48	0.10	1.84	0.308	Smaller individuals harvested & no change in population
Hipposcarus longiceps	0.40	0.16	0.06	3.97	0.060						
Kyphosus cinerascens	0.08	0.01	0.05	0.14	0.715	0.85	0.72	0.04	5.20	0.150	No change in population
Lethrinus atkinsoni	0.41	0.17	0.06	4.20	0.053						
Lethrinus harak	0.50	0.25	0.02	7.02	0.015						
Lethrinus obsoletus	0.38	0.14	0.02	3.48	0.076						
Lethrinus olivaceus	0.28	0.08	0.06	1.81	0.193						
Lethrinus rubrioperculatus	0.35	0.13	0.03	3.01	0.097						
Lethrinus xanthochilus	0.11	0.01	0.07	0.28	0.602	0.73	0.53	0.11	2.26	0.272	No change in population
Lutjanus fulvus	0.51	0.26	0.02	7.54	0.013	0.40	0.16	0.02	0.38	0.600	Smaller individuals harvested & no change in population
Lutjanus kasmira	0.62	0.38	0.02	13.14	0.002	0.62	0.39	0.10	1.27	0.377	Smaller individuals harvested & no change in population
Lutjanus monostigma	0.41	0.17	0.05	4.24	0.052	0.58	0.34	0.02	1.04	0.415	Smaller individuals harvested & no change in population

Moolgarda engeli											
Mulloidichthys flavolineatus	0.12	0.01	0.04	0.29	0.594	0.33	0.11	0.21	0.24	0.672	No change in population
Mulloidichthys ti'ao	0.41	0.17	0.02	4.24	0.052						
Myripristis berndti	0.39	0.15	0.05	3.79	0.065	0.67	0.45	0.02	1.65	0.328	No change in population
Naso lituratus	0.27	0.07	0.03	1.65	0.213	0.76	0.57	0.14	2.70	0.242	No change in population
Naso unicornis	0.05	0.00	0.03	0.06	0.809	0.73	0.53	0.22	2.29	0.269	No change in population
Parupeneus barberinus	0.11	0.01	0.08	0.25	0.623	0.39	0.15	0.12	0.35	0.615	No change in population
Parupeneus bifasciatus	0.40	0.16	0.05	4.05	0.057	0.08	0.01	0.06	0.01	0.917	No change in population
Parupeneus multifasciatus	0.48	0.23	0.02	6.38	0.020	0.85	0.72	0.05	5.06	0.153	Enhanced harvest with no impact to population
Pristipomoides auricilla	0.08	0.01	0.02	0.14	0.717						
Pristipomoides zonatus	0.12	0.01	0.02	0.30	0.592						
Rhinecanthus aculeatus	0.43	0.18	0.09	4.68	0.047						
Sargocentron spiniferum	0.32	0.10	0.02	2.41	0.136	0.06	0.00	0.08	0.01	0.941	No change in population
Sargocentron tiere	0.49	0.24	0.04	6.46	0.011	0.70	0.49	0.04	1.95	0.297	Smaller individuals harvested & no change in population
Scarus altipinnis	0.70	0.49	0.04	20.07	0.000	0.40	0.16	0.07	0.38	0.601	Smaller individuals harvested & no change in population
Scarus psittacus	0.55	0.30	0.03	8.90	0.003	0.07	0.00	0.11	0.01	0.934	Smaller individuals harvested & no change in population
Scarus schlegeli	0.58	0.34	0.04	10.66	0.001	0.66	0.43	0.05	1.53	0.342	Smaller individuals harvested & no change in population
Selar crumenophthalmus	0.28	0.08	0.05	1.78	0.197						
Siganus argenteus	0.33	0.11	0.09	2.58	0.123	0.60	0.36	0.06	1.15	0.397	No change in population
Siganus spinus	0.02	0.00	0.04	0.01	0.933						
Variola louti	0.30	0.09	0.04	2.09	0.163	0.93	0.86	0.02	12.01	0.074	No change in population

Trend interpretation		
Catch	UVC	Enhanced harvest & population recovery/improving
Catch	UVC	Larger individuals harvested & population recruiting
Catch	UVC	Smaller individuals harvested & increasing adult population
Catch	UVC	No change in fished population w/ recruitment ongoing
Catch	UVC	Smaller individuals harvested & no change in population
Catch	UVC	No change in population
Catch	UVC	Enhanced harvest with no impact to population
Catch	UVC	Sustainable harvest & population recovering/improving
Catch	UVC	Population/stock is being impacted by fishing

Options for ABC specification using the time series of catch

1. American Samoa
2. Commonwealth of Northern Mariana Islands
3. Guam
4. Hawaii

LIST OF ALTERNATIVES FOR ACL SPECIFICATION IN THE CORAL REEF FISHERY IN AMERICAN SAMOA

Alternative 1.A. No Action

Alternative 1.B.: All CREMUS groupings aggregated

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
ALL CREMUS	105,403	45,534	150,937	196,471	97,332	126,610	166,541

Alternative 1.C.Top 90% of CREMUS landing and rest of 10% binned together

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Surgeonfish	16,261	12,229	28,490	40,719	12,838	19,516	37,175
Snapper	15,850	7,025	22,875	29,900	14,324	21,607	27,391
Jacks	8,223	6,996	15,220	22,216	6,304	10,868	17,077
Emperor	7,667	4,509	12,175	16,684	6,185	10,255	15,112
Parrotfish*	6,311	6,654	12,965	19,619	3,959	8,145	18,278
Grouper	6,159	1,801	7,961	9,762	5,904	7,632	8,756
Squirrelfish	2,759	2,477	5,236	7,713	2,087	2,585	7,304
Remaining 10%	27,555	32,292	59,847	92,139	17,926	31,497	75,539

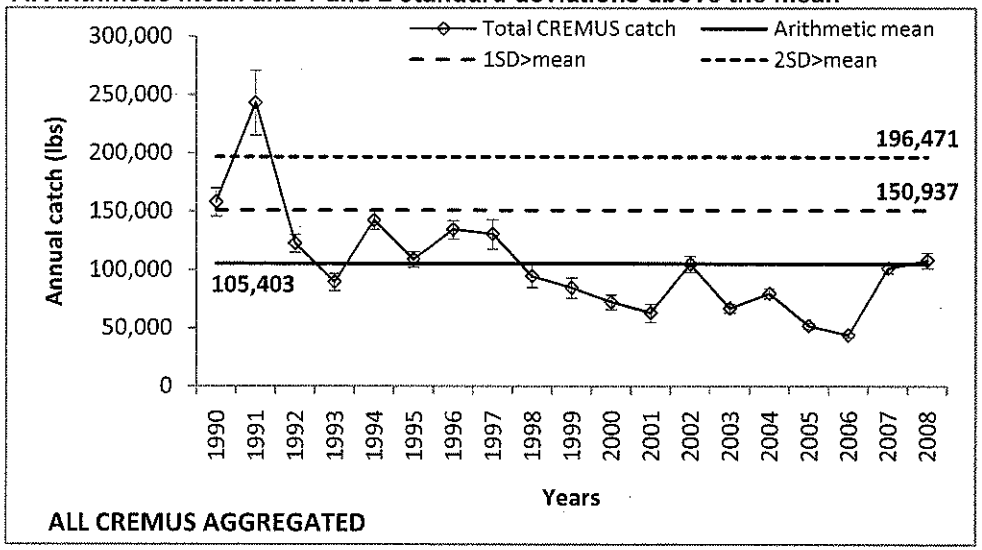
Alternative 1.D.: Individual CREMUS groupings

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Surgeonfish	16,261	12,229	28,490	40,719	12,838	19,516	37,175
Snapper	15,850	7,025	22,875	29,900	14,324	21,607	27,391
Jacks	8,223	6,996	15,220	22,216	6,304	10,868	17,077
Emperor	7,667	4,509	12,175	16,684	6,185	10,255	15,112
Parrotfish*	6,311	6,654	12,965	19,619	3,959	8,145	18,278
Grouper	6,159	1,801	7,961	9,762	5,904	7,632	8,756
Squirrelfish	2,759	2,477	5,236	7,713	2,087	2,585	7,304
Atule	14,060	29,337	43,397	72,733	2,330	8,396	63,722
Mullets	2,679	4,336	7,015	11,351	1,054	2,857	7,727
Goatfish	550	438	988	1,425	310	847	1,332
Wrasse**	949	1,221	2,170	3,392	492	1,253	3,004
Rabbitfish	134	162	296	458	84	126	388
Rudderfish	573	452	1,025	1,477	319	843	1,323
Mollusk	11,601	9,431	21,032	30,462	6,058	16,694	27,001
Crustacean	1,967	1,463	3,430	4,893	1,550	2,248	4,788
Other fin fish***	13,021	7,550	20,571	28,121	11,011	17,124	25,178

NOTE: * excludes Bolbometopon muricatum (bumphead parrotfish)
** excludes Cheilinus undulatus (humphead wrasse)
*** includes reef sharks

Figure 12. Temporal trend in annual catch of aggregated CREMUS complex in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

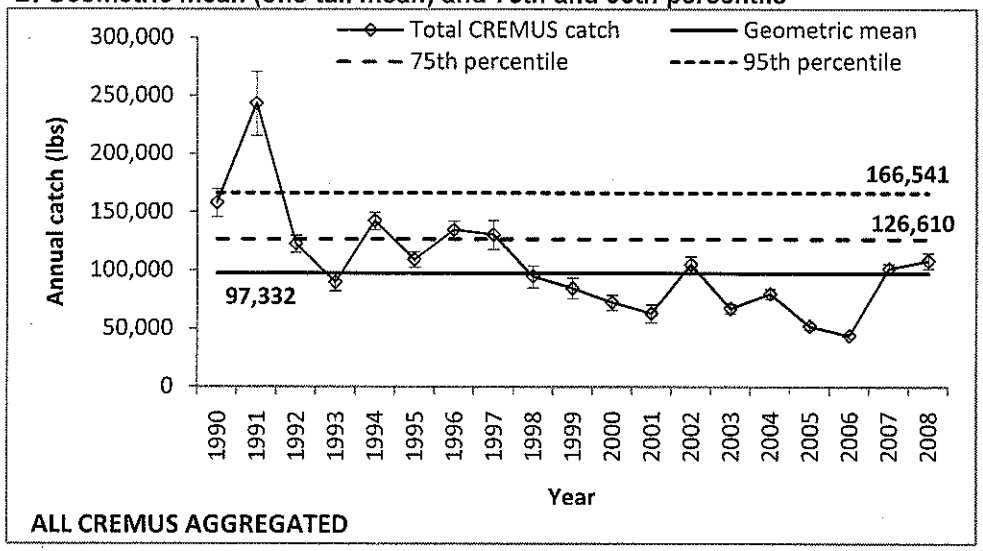
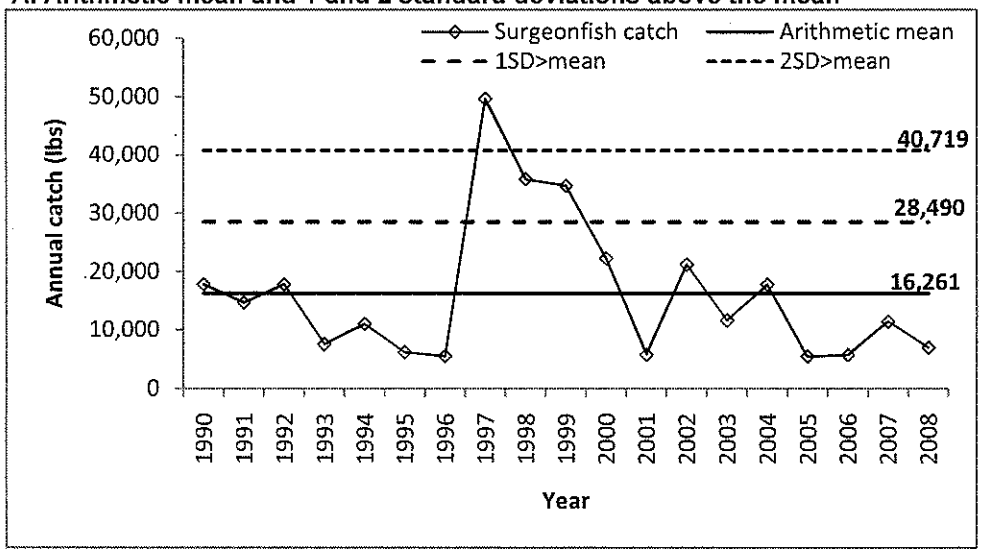


Figure 13. Temporal trend in annual catch of Acanthuridae (surgeonfish) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

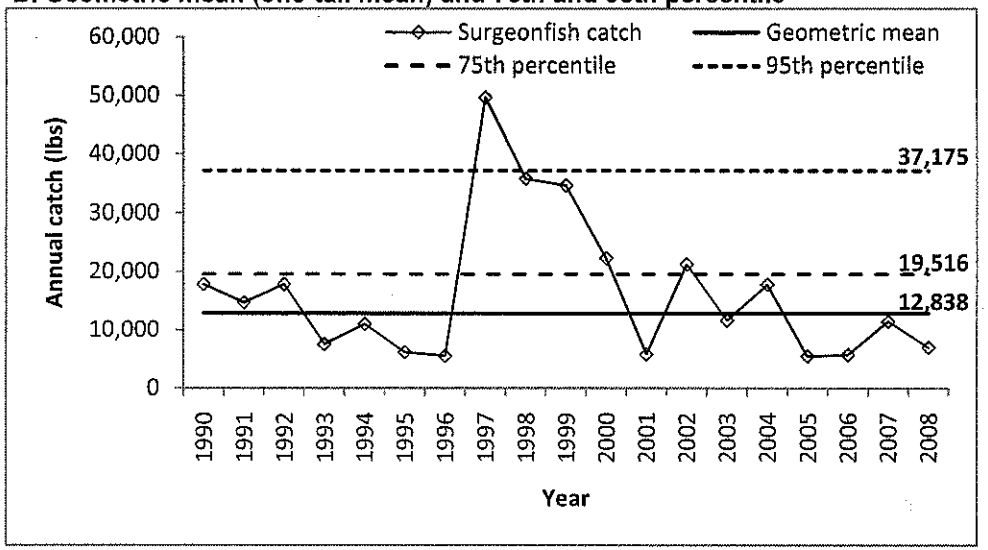
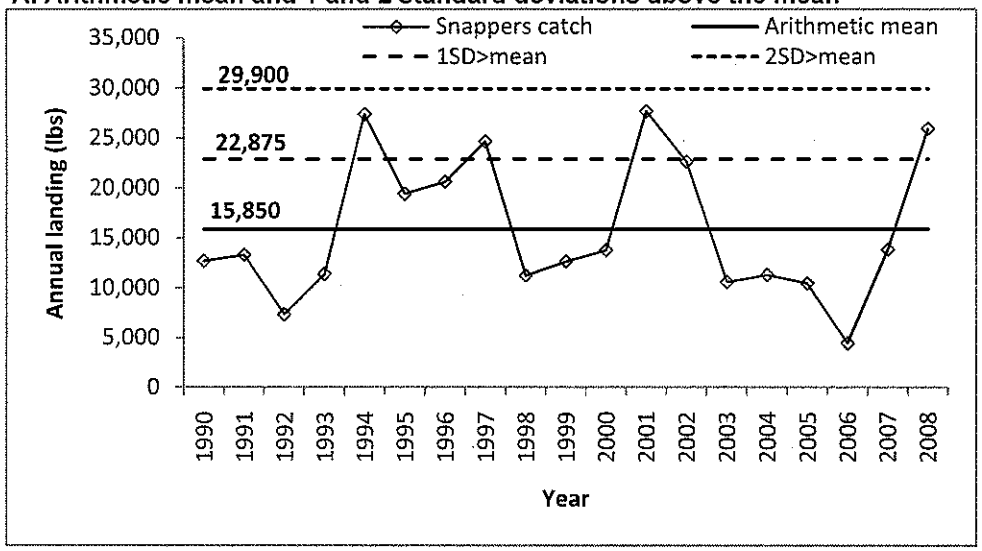


Figure 14. Temporal trend in annual catch of Lutjanidae (snappers) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

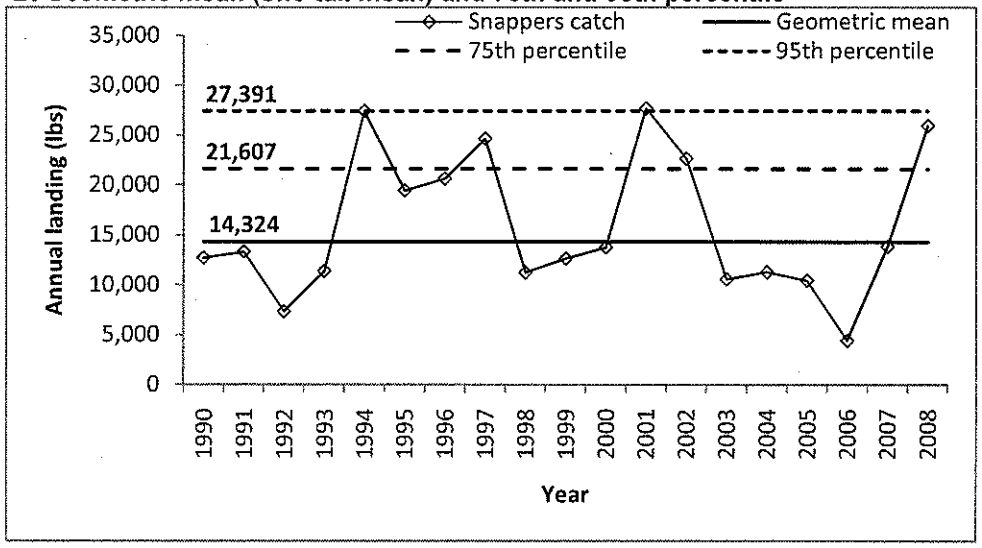
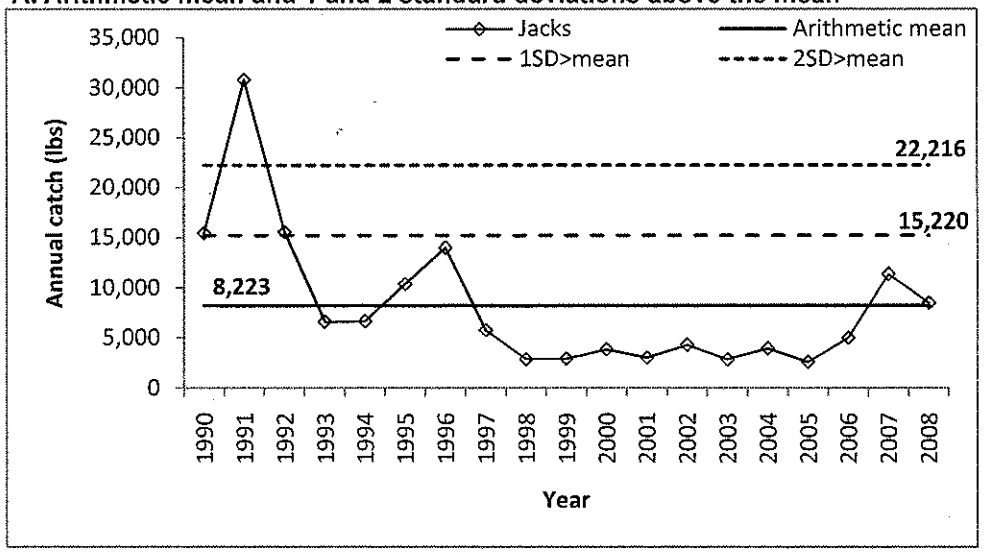


Figure 15. Temporal trend in annual catch of Carangidae (jacks) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

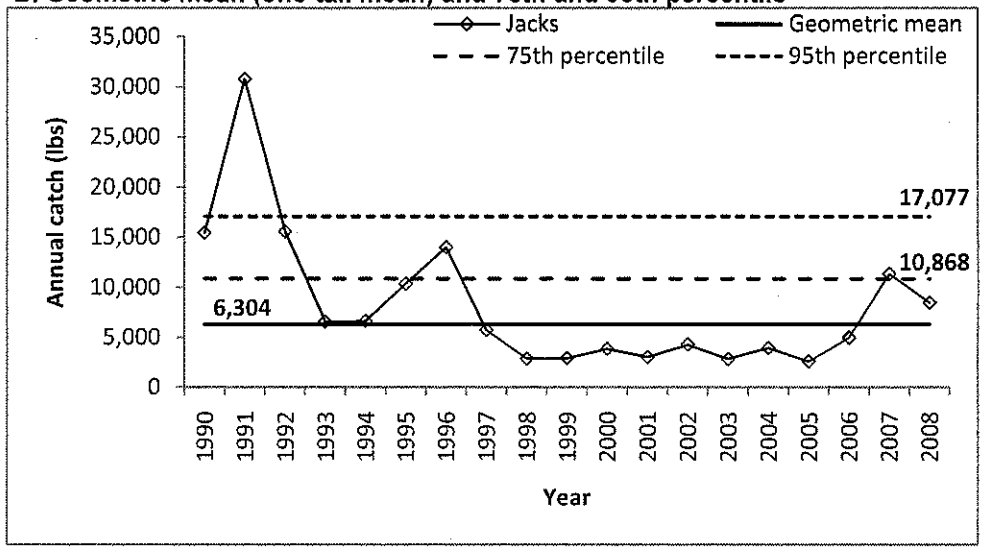
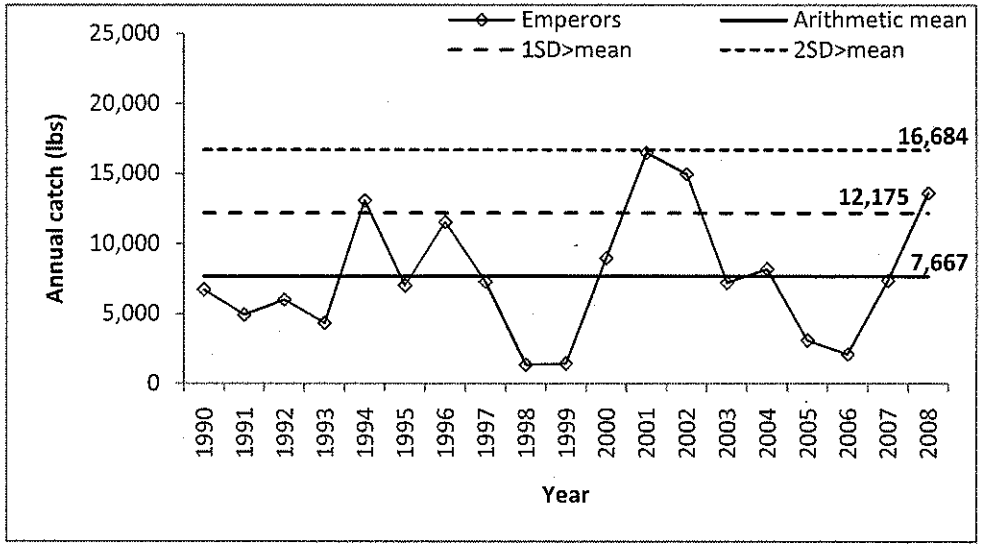


Figure 16. Temporal trend in annual catch of Lethrinidae (emperors) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

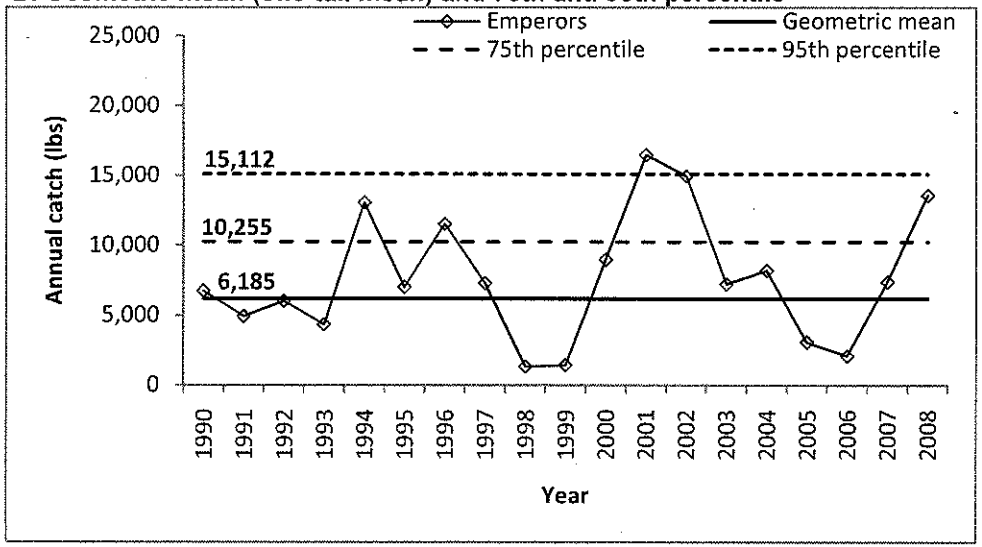
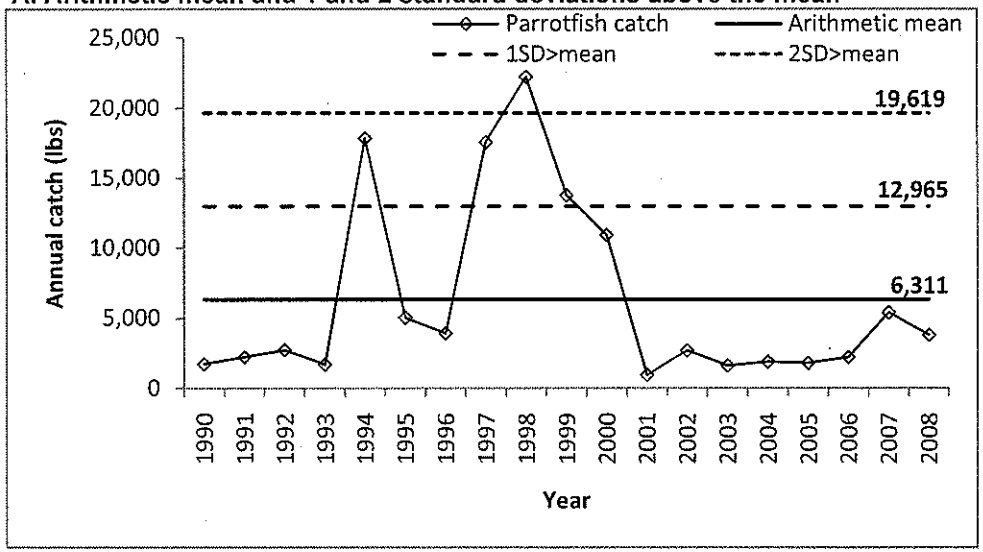


Figure 17. Temporal trend in annual catch of Scaridae (parrotfish) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

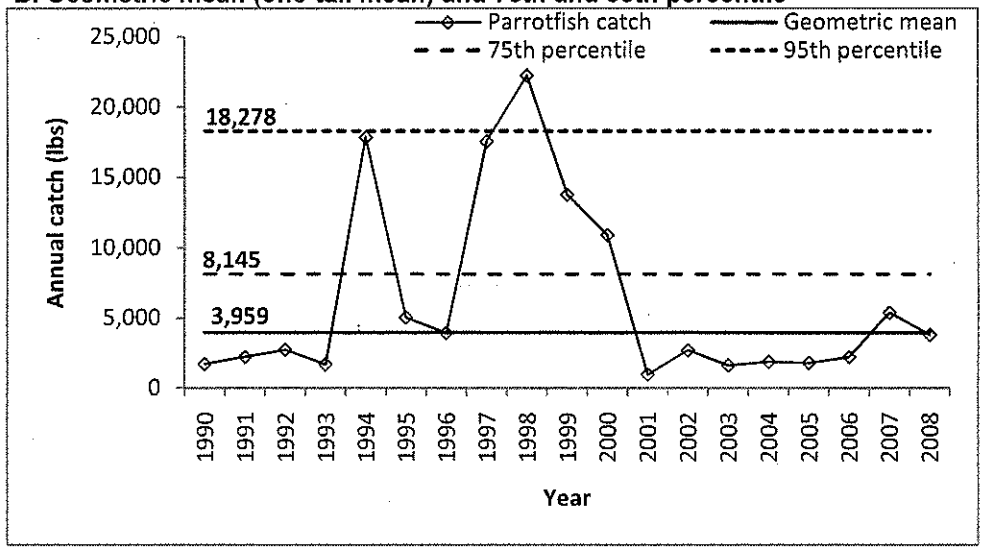
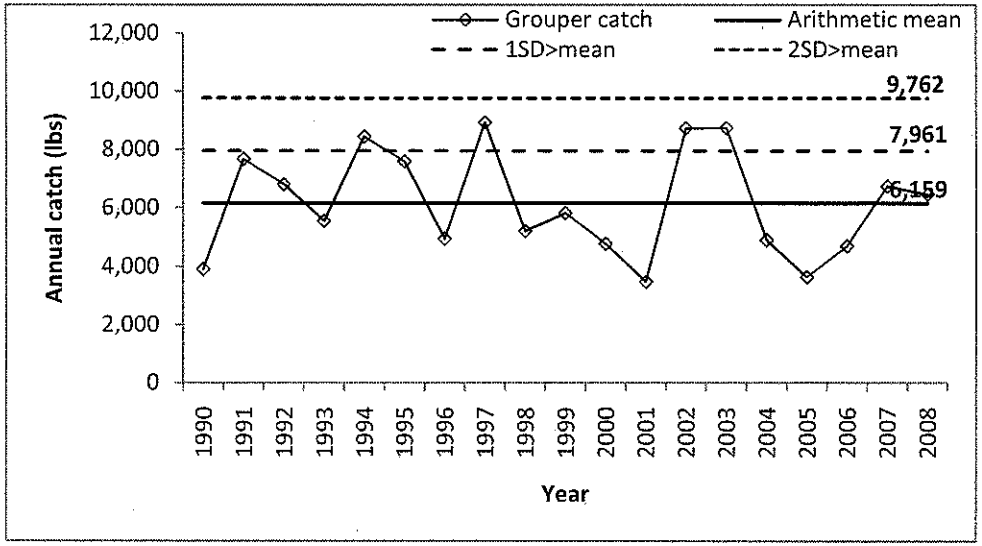


Figure 18. Temporal trend in annual catch of Serranidae (groupers) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

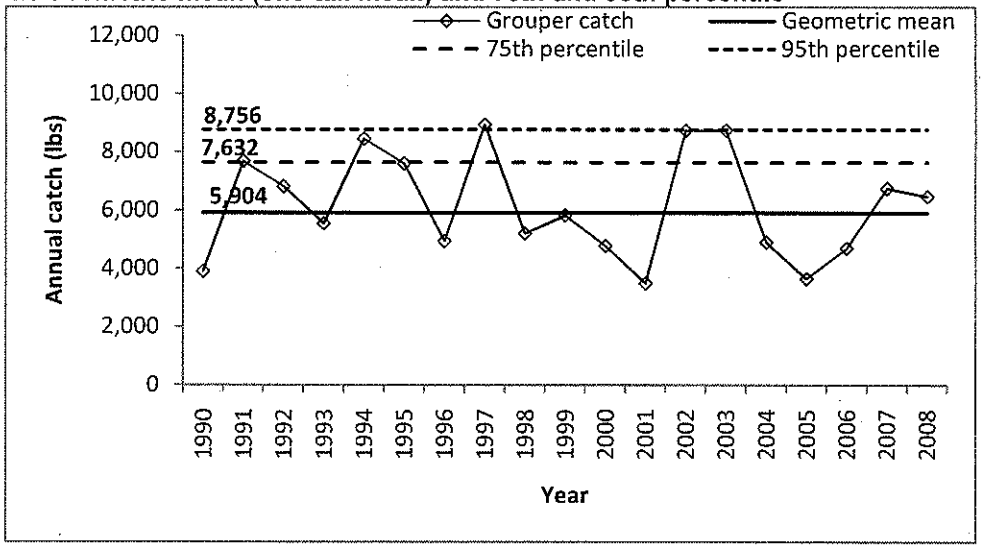
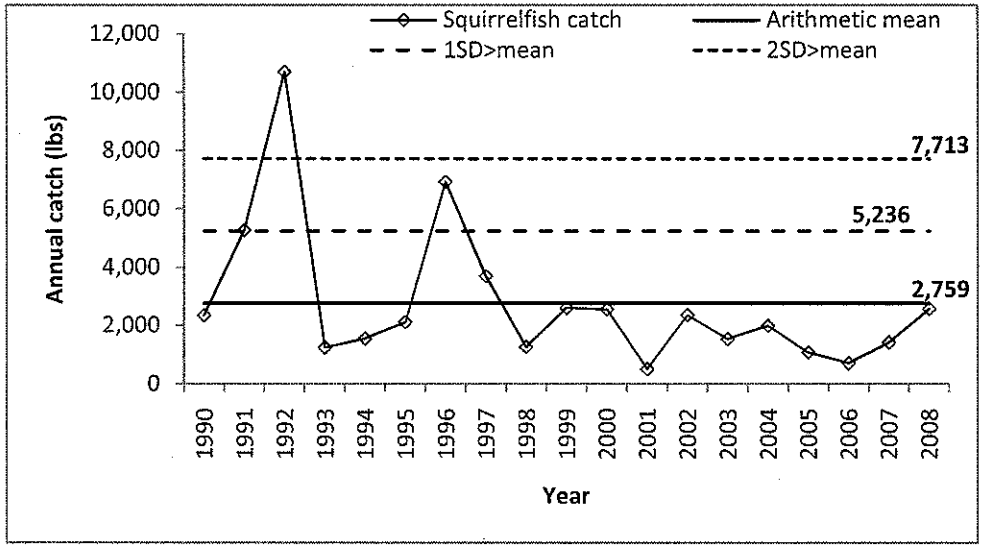


Figure 19. Temporal trend in annual catch of Holocentridae (squirrelfish) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

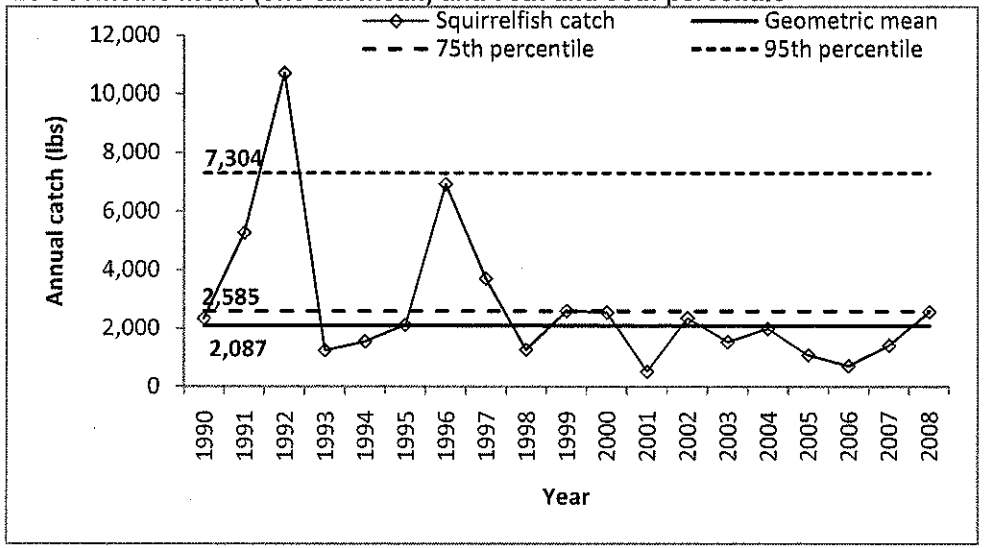
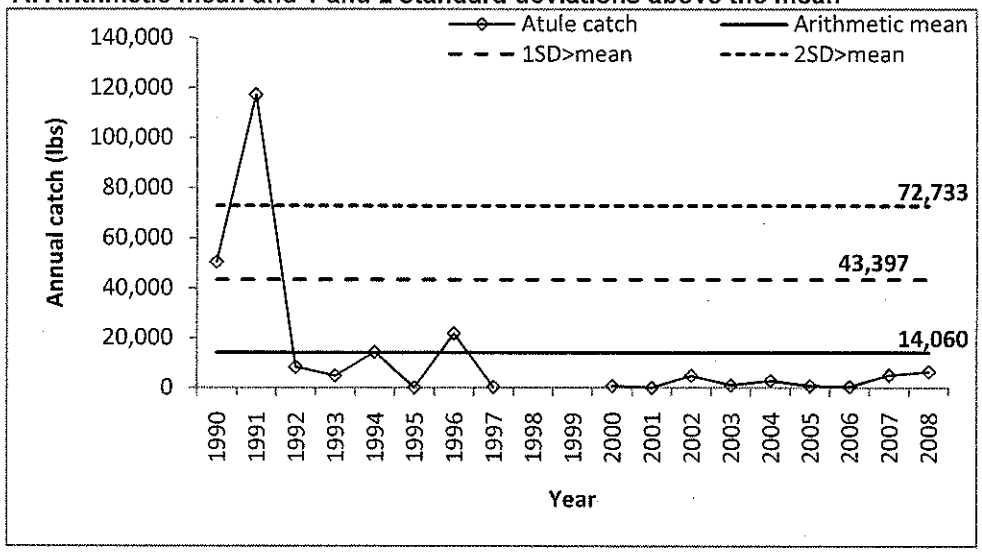


Figure 20. Temporal trend in annual catch of Selar crumenopthalmus in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

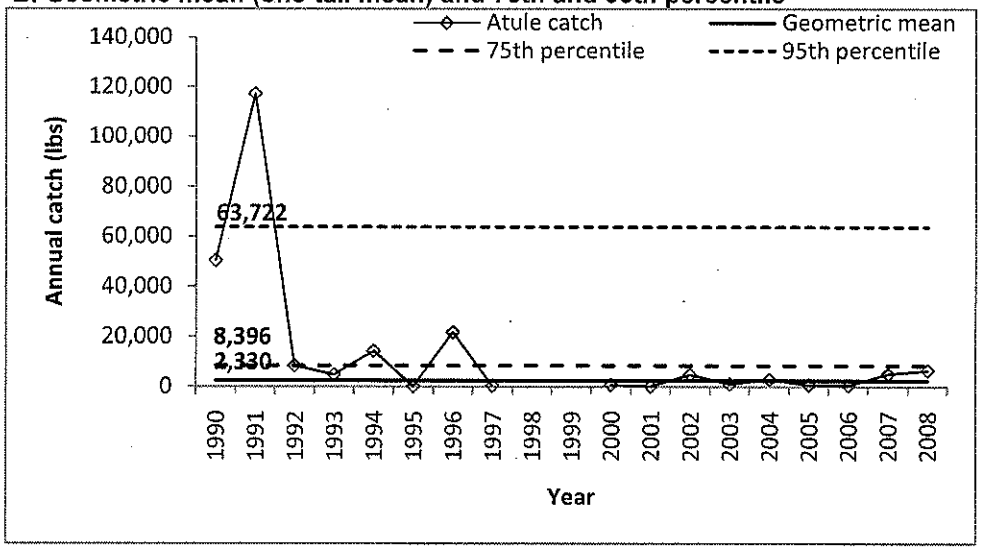
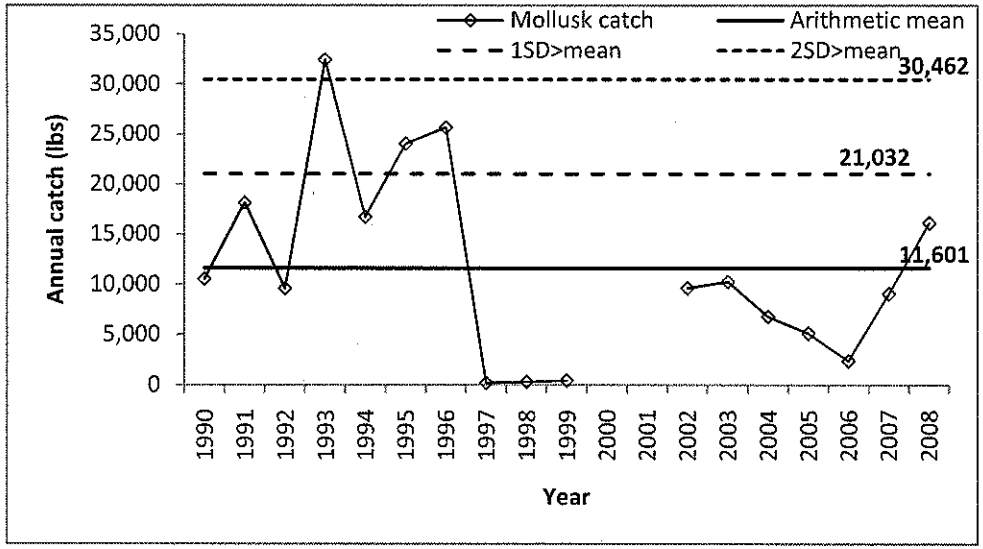


Figure 21. Temporal trend in annual catch of mollusks in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

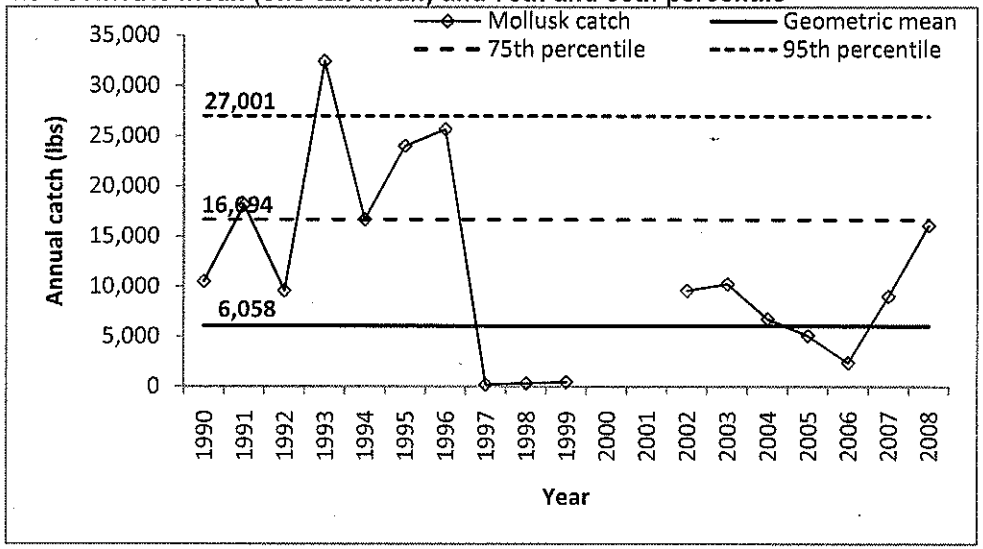
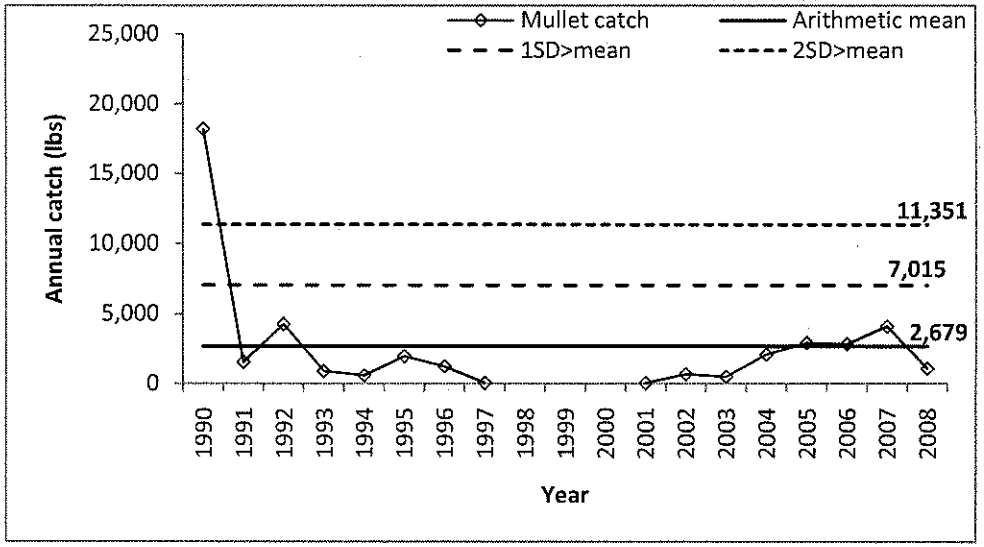


Figure 22. Temporal trend in annual catch of Mugilidae (mullets) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

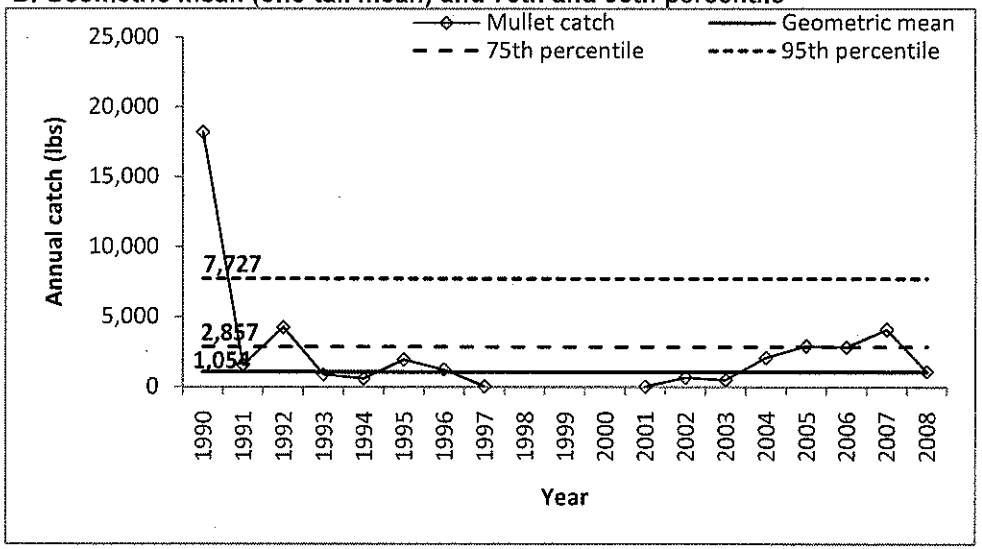
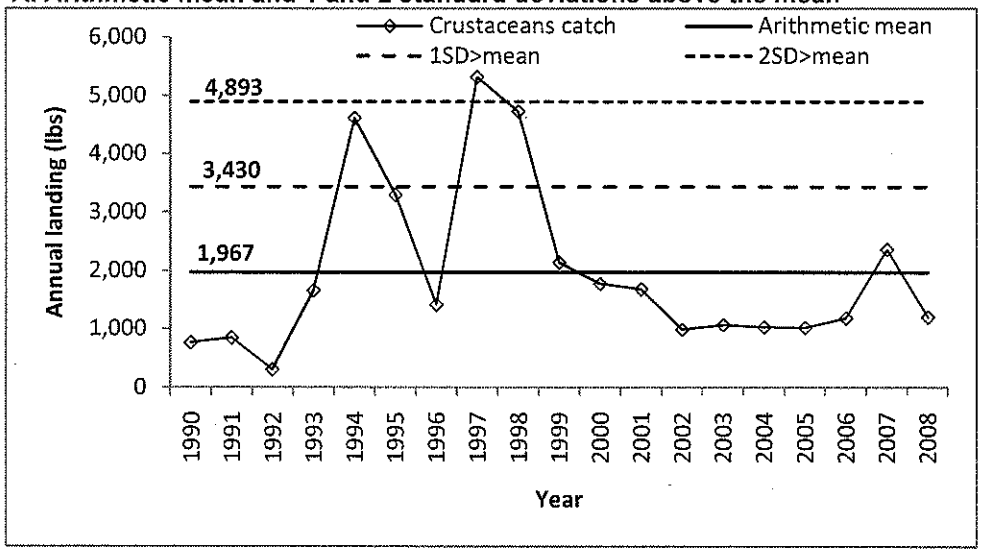


Figure 23. Temporal trend in annual catch of crustaceans in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

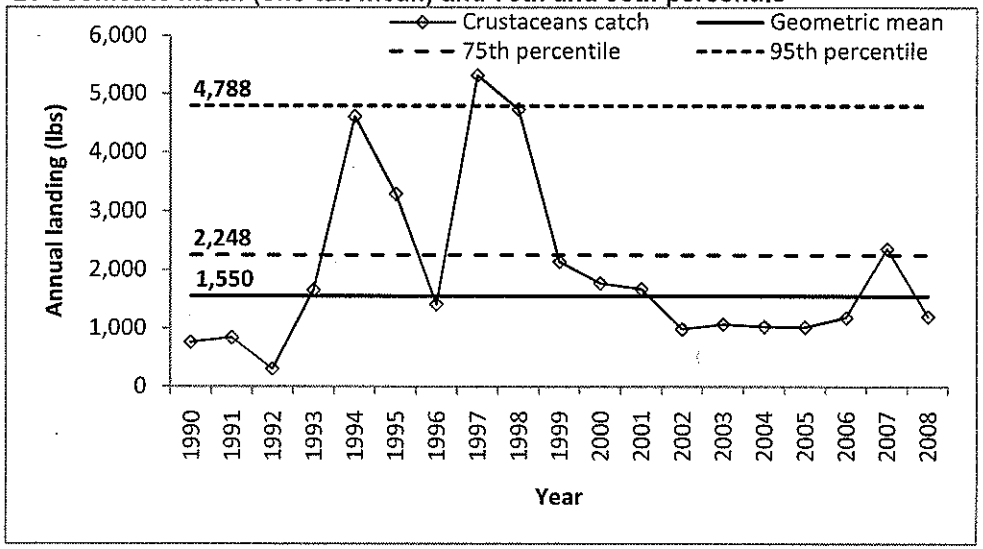
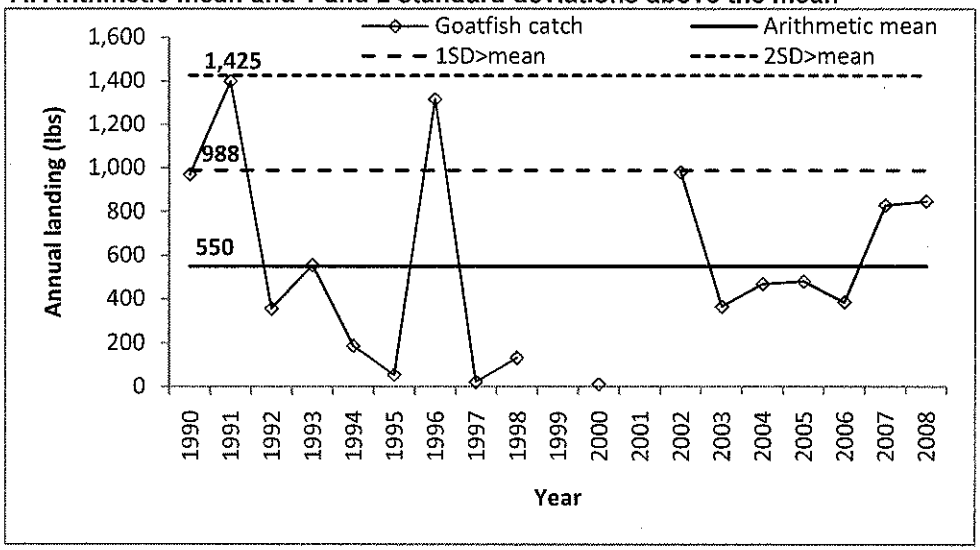


Figure 24. Temporal trend in annual catch of Mullidae (goatfish) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

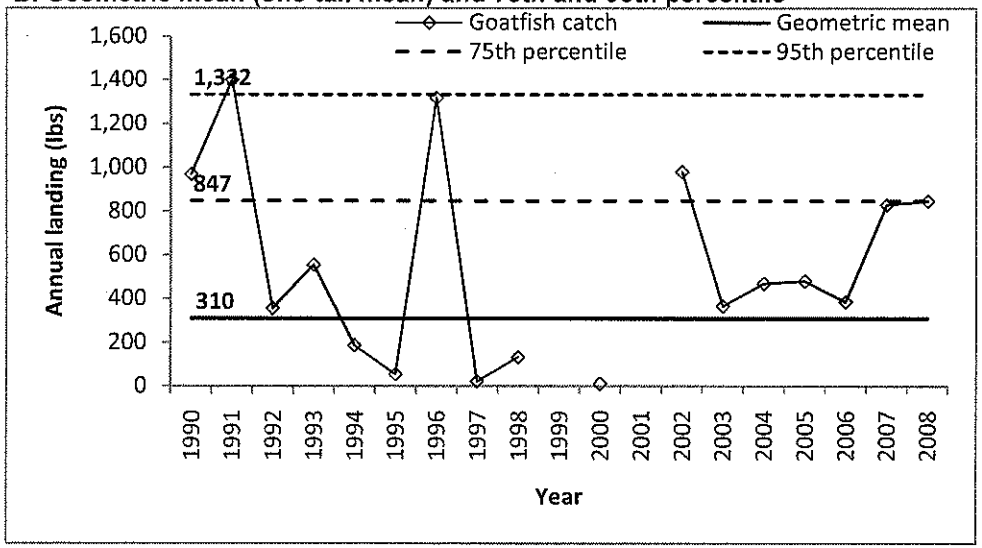
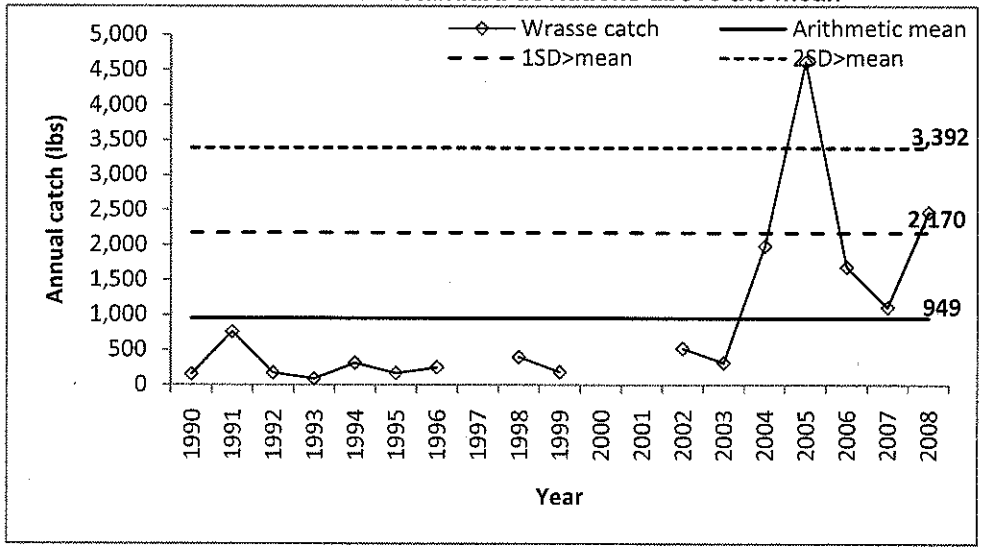


Figure 25. Temporal trend in annual catch of Labridae (wrasses not including C. undulatus) in American Samoa showing 2 types of central tendencies and variations

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

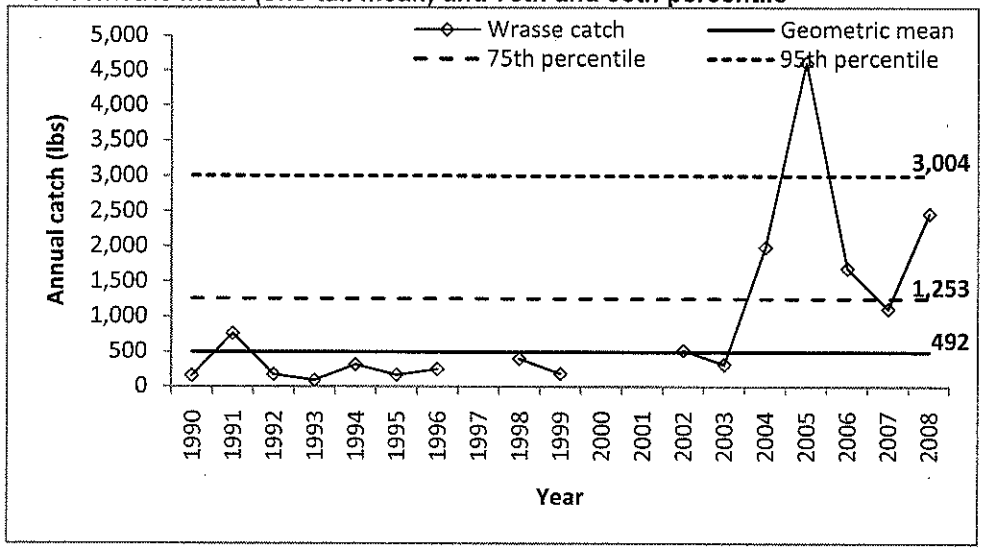
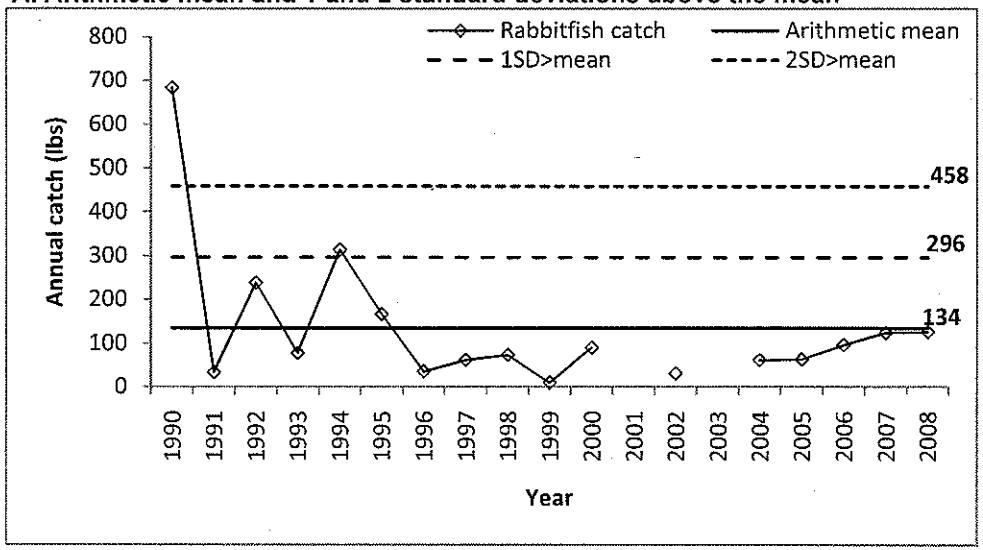


Figure 26. Temporal trend in annual catch of Siganidae (rabbitfish) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

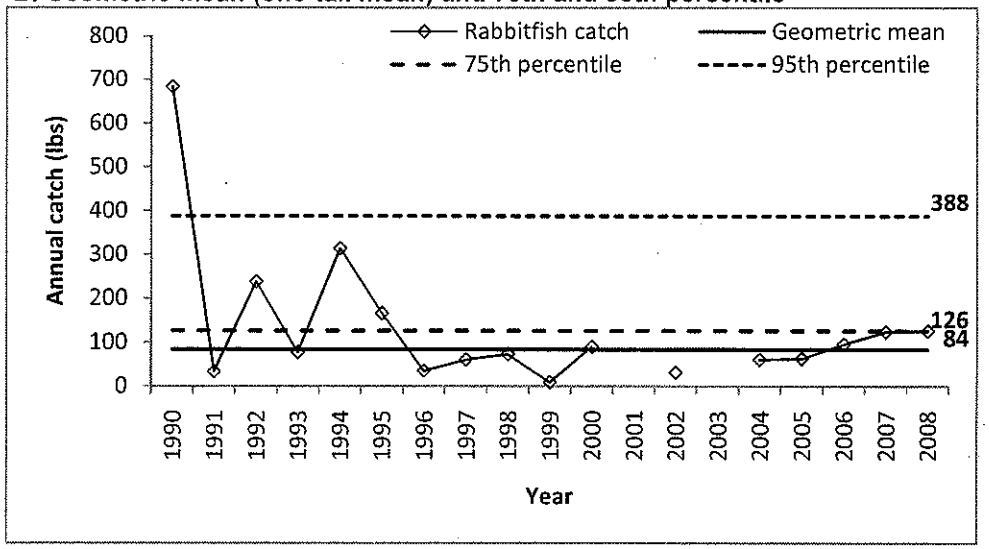
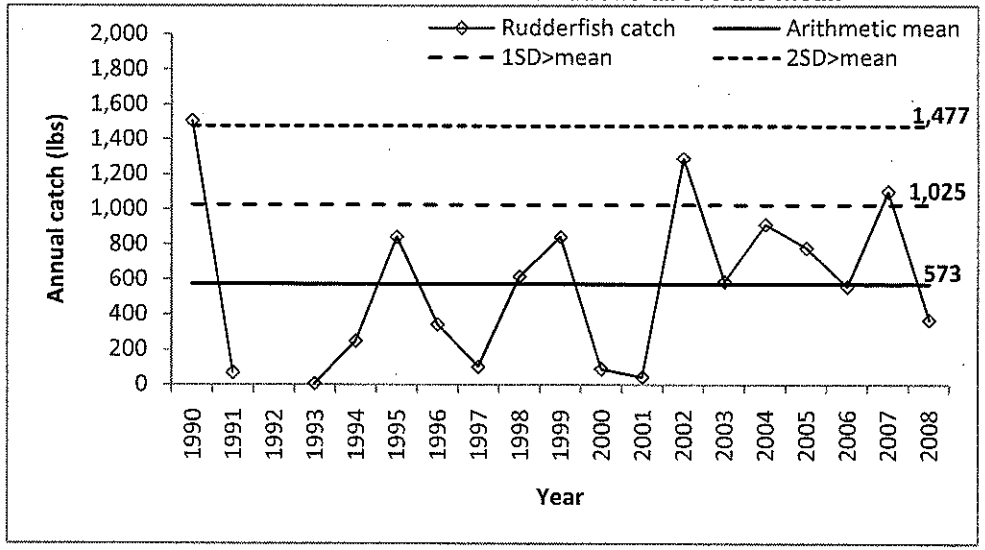


Figure 27. Temporal trend in annual catch of Kyphosidae (rudderfish) in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

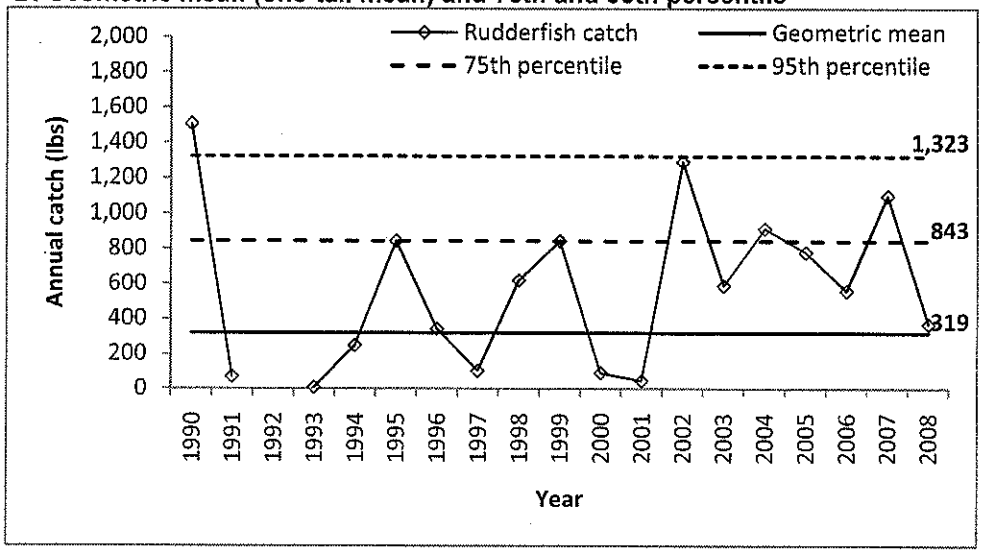
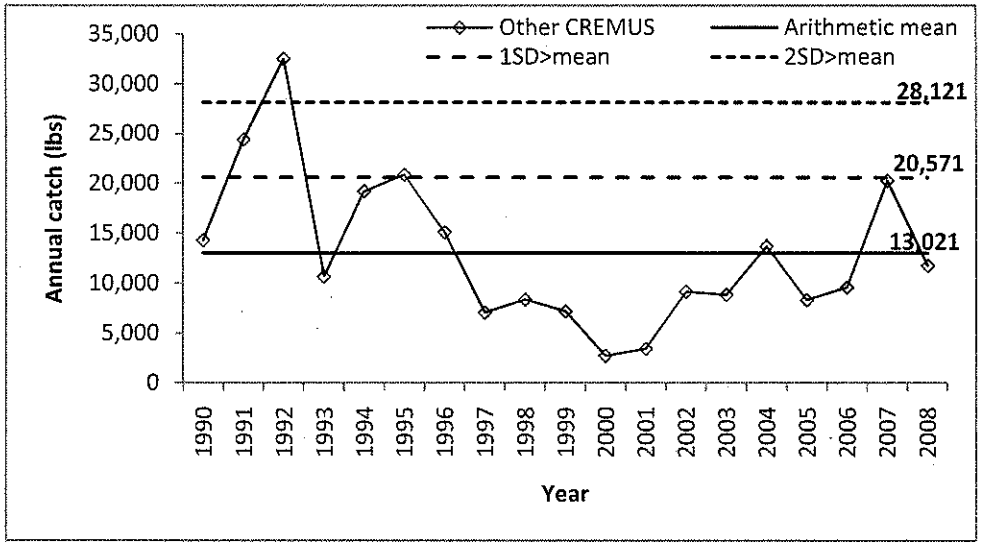


Figure 28. Temporal trend in annual catch of other CREMUS in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

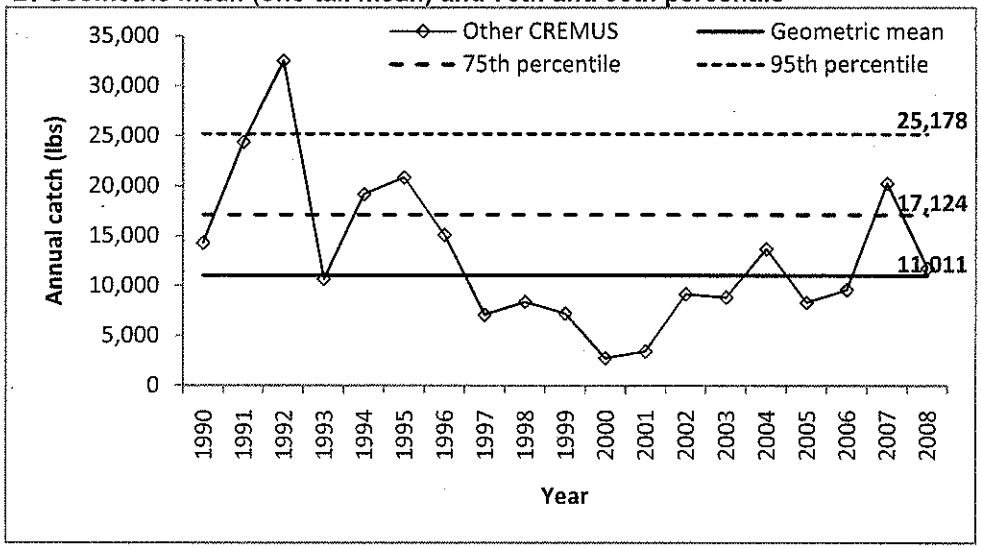
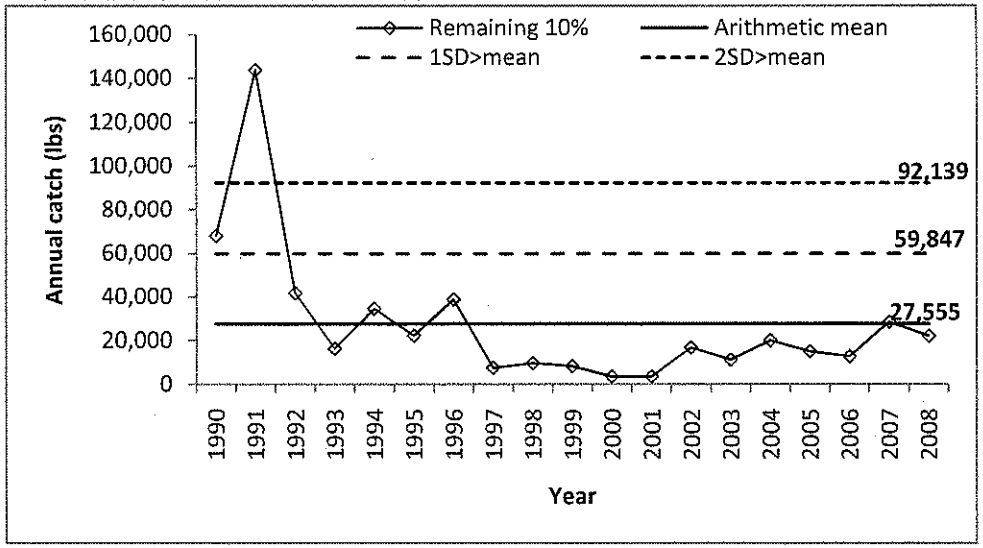
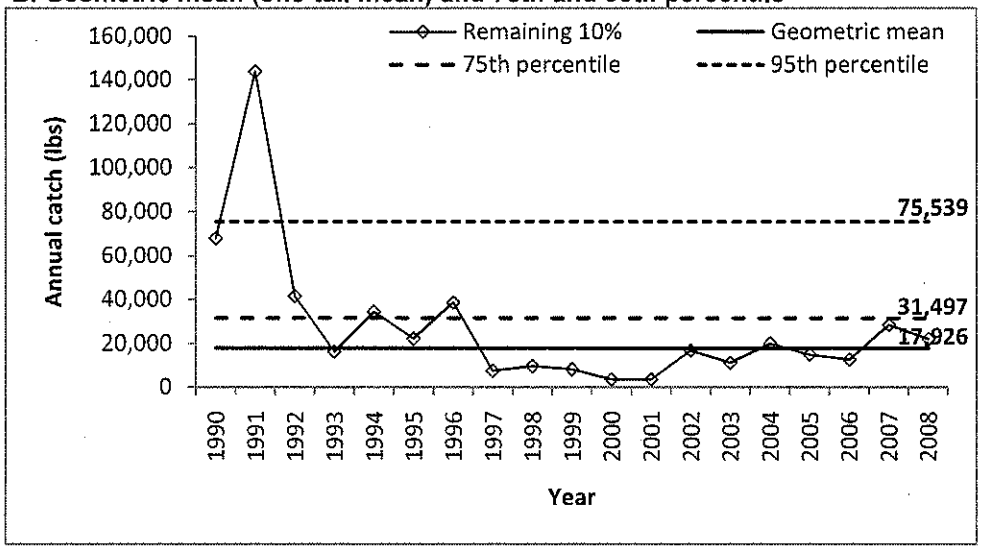


Figure 29. Temporal trend in annual catch of the remaining 10% of the CREMUS landing in American Samoa showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile



LIST OF ALTERNATIVES FOR ACL SPECIFICATION IN THE CORAL REEF FISHERY IN CNMI

Alternative 1.A. No Action

Alternative 1.B.: All CREMUS groupings aggregated

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
ALL CREMUS	73,938	31,361	105,299	136,660	67,317	100,725	106,668

Alternative 1.C.: Top 90% of CREMUS landing and rest of 10% binned together

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Emperor	23,413	11,827	35,240	47,066	19,730	27,466	39,186
Jacks	14,968	8,456	23,424	31,879	12,674	21,512	26,607
Surgeonfish	5,517	2,706	8,223	10,929	4,924	6,884	9,469
Atule	5,024	4,922	9,946	14,868	2,471	7,459	12,419
Grouper	4,220	1,644	5,864	7,507	3,828	5,519	6,179
Snapper	3,367	1,697	5,064	6,760	3,050	3,905	5,968
Goatfish	3,323	2,917	6,239	9,156	2,083	3,670	7,972
Parrotfish*	2,672	1,581	4,253	5,833	2,239	3,784	4,832
Other fin fish***	3,445	2,460	5,905	8,364	2,327	5,787	6,024
Remaining 10%	10,868	9,296	20,164	29,460	7,516	16,954	25,153

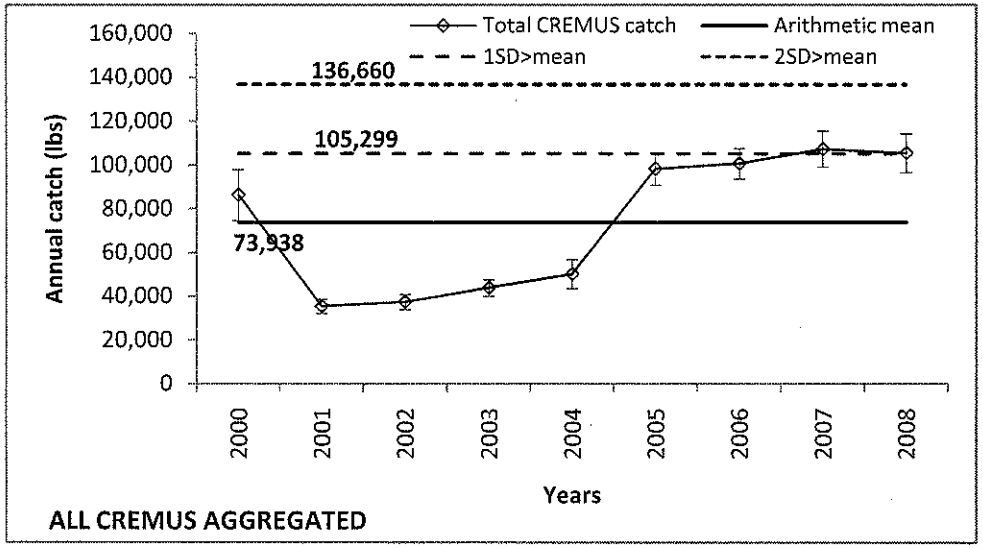
Alternative 1.D.: Individual CREMUS groupings

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Emperor	23,413	11,827	35,240	47,066	19,730	27,466	39,186
Jacks	14,968	8,456	23,424	31,879	12,674	21,512	26,607
Surgeonfish	5,517	2,706	8,223	10,929	4,924	6,884	9,469
Atule	5,024	4,922	9,946	14,868	2,471	7,459	12,419
Grouper	4,220	1,644	5,864	7,507	3,828	5,519	6,179
Snapper	3,367	1,697	5,064	6,760	3,050	3,905	5,968
Goatfish	3,323	2,917	6,239	9,156	2,083	3,670	7,972
Parrotfish*	2,672	1,581	4,253	5,833	2,239	3,784	4,832
Other fin fish***	3,445	2,460	5,905	8,364	2,327	5,787	6,024
Mollusk	2,693	3,194	5,887	9,080	853	4,446	7,188
Mullets	2,268	1,427	3,694	5,121	1,536	3,308	3,915
Rabbitfish	1,441	1,427	2,868	4,295	660	2,537	3,633
Squirrelfish	1,307	1,400	2,707	4,107	798	1,311	3,646
Wrasse**	902	1,056	1,959	3,015	383	1,200	2,670
Rudderfish	600	303	903	1,206	530	706	1,022
Crustacean	n/d	n/d	n/d	n/d	n/d	n/d	n/d

NOTE: * excludes Bolbometopon muricatum (bumphead parrotfish)
** excludes Cheilinus undulatus (humphead wrasse)
*** includes reef sharks

Figure 30. Temporal trend in annual catch of all species listed under CREMUS in CNMI (Saipan) showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

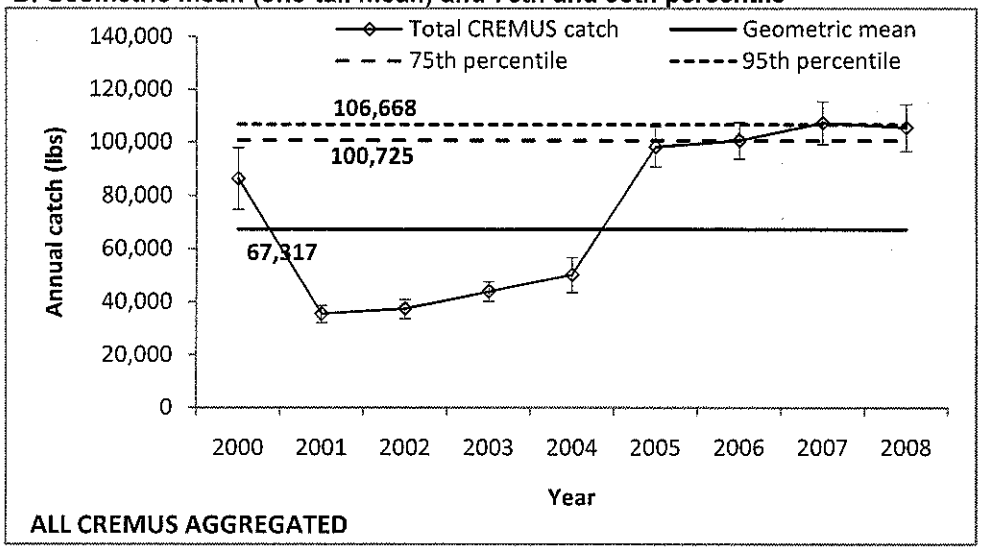
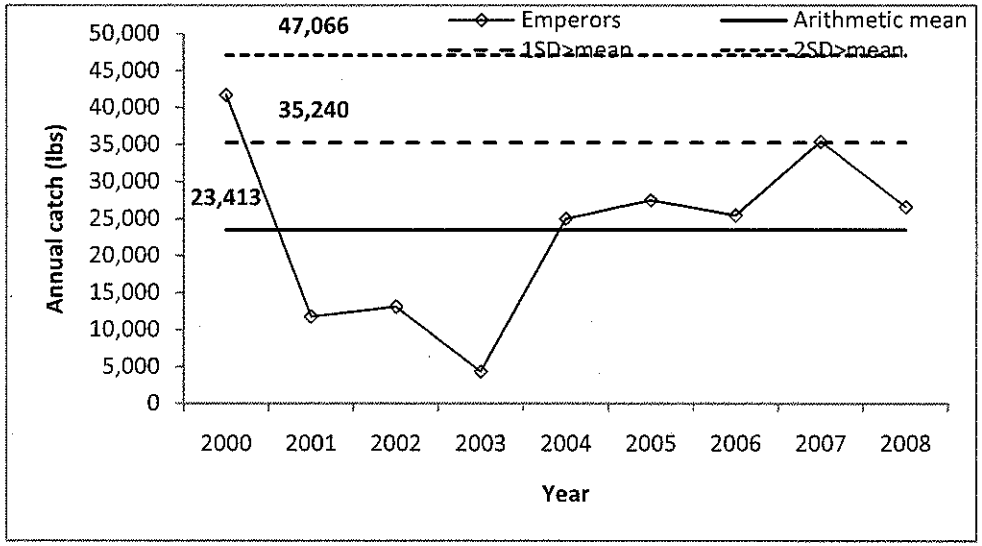


Figure 31. Temporal trend in annual catch of Lethrinidae (emperors) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

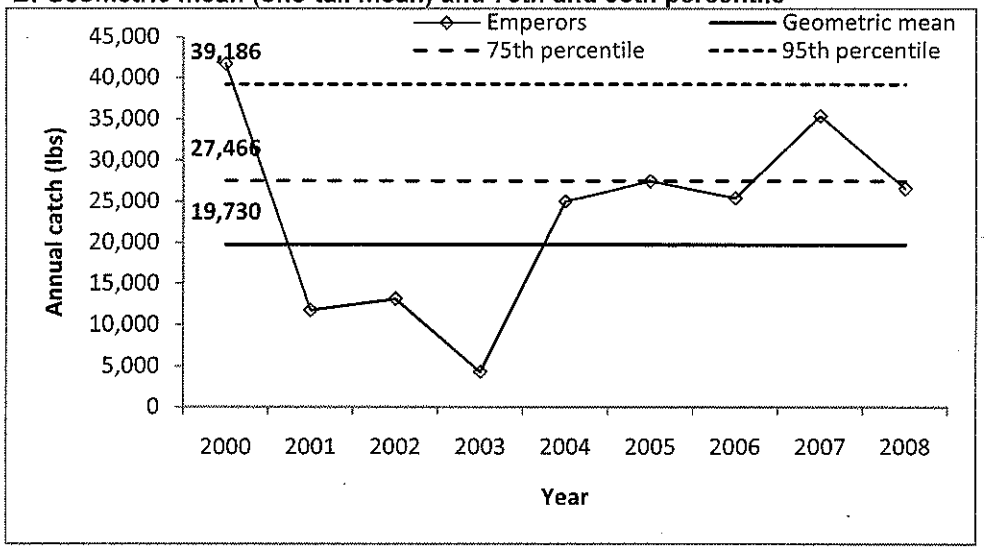
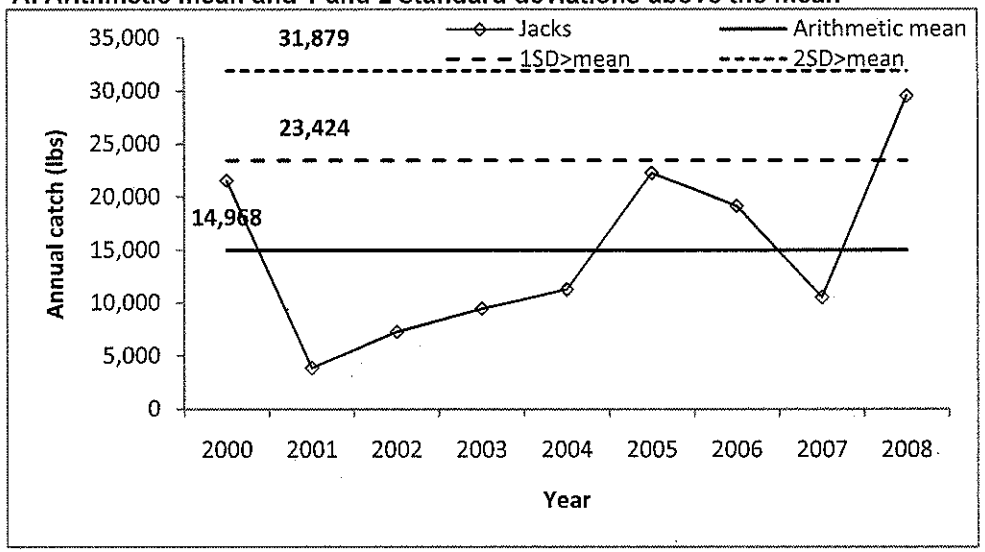


Figure 32. Temporal trend in annual catch of Carangidae (jacks) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

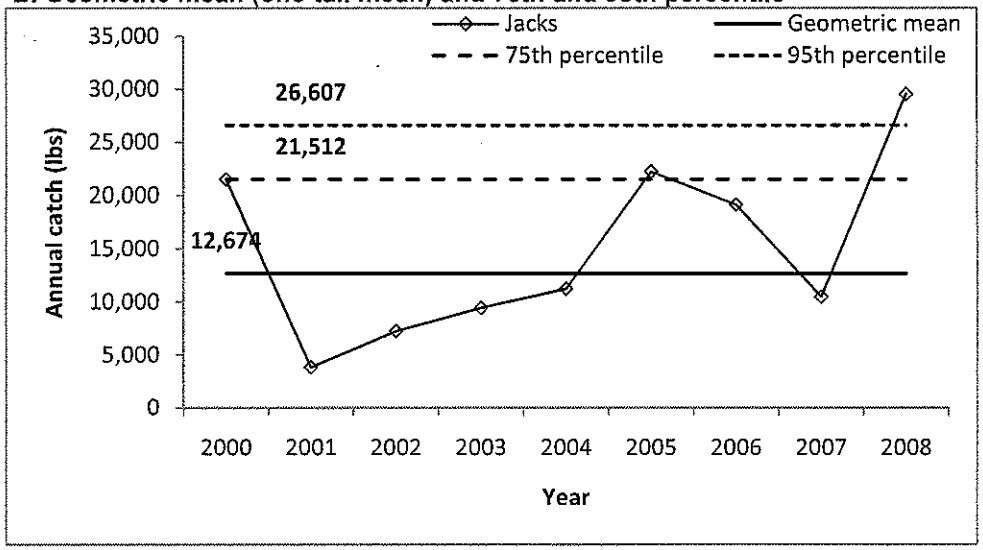
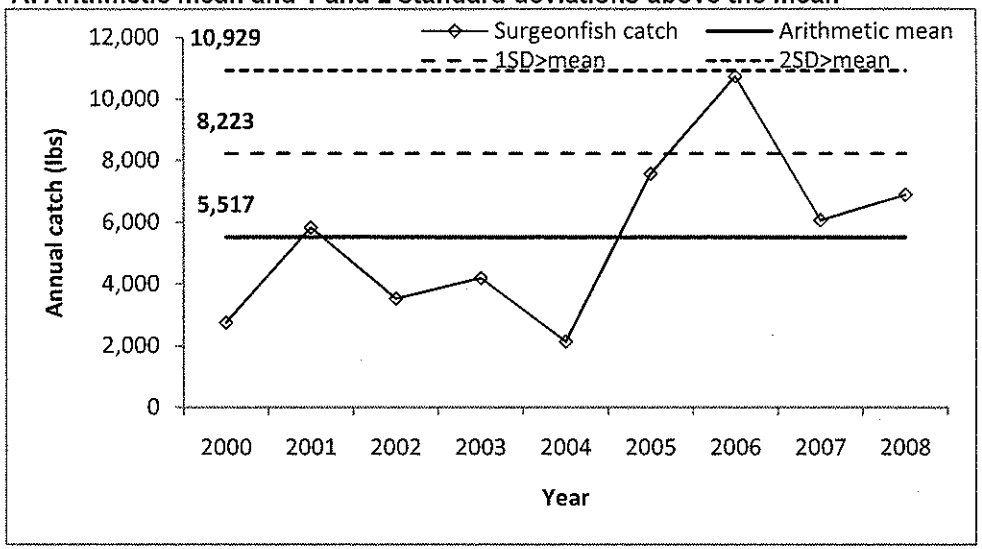


Figure 33. Temporal trend in annual catch of Acanthuridae (surgeonofish) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

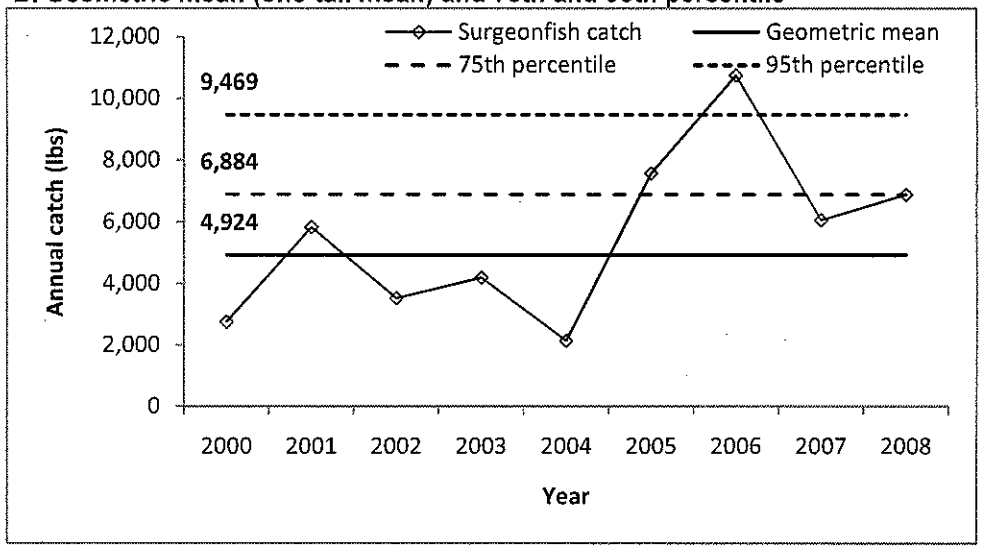
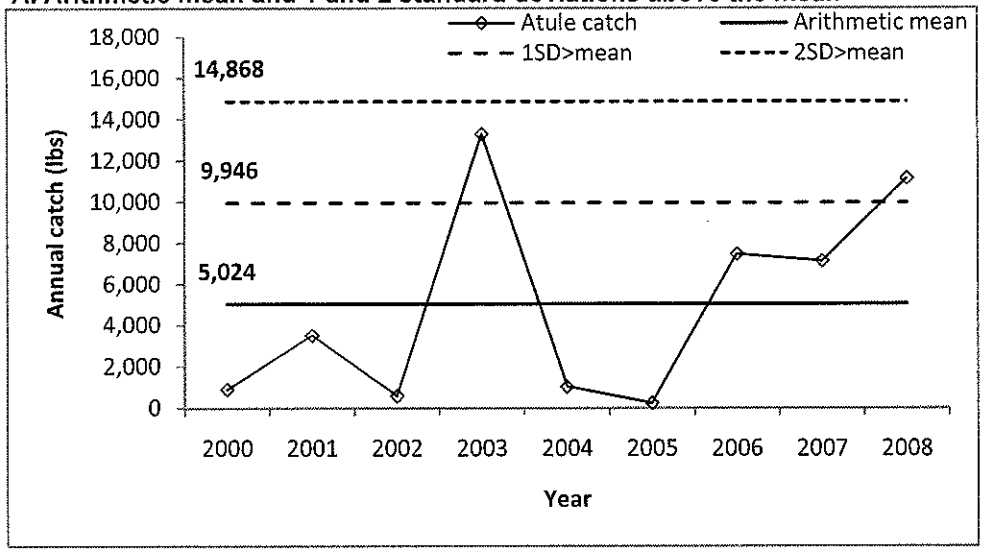


Figure 34. Temporal trend in annual catch of Selar crumenopthalmus (atule) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

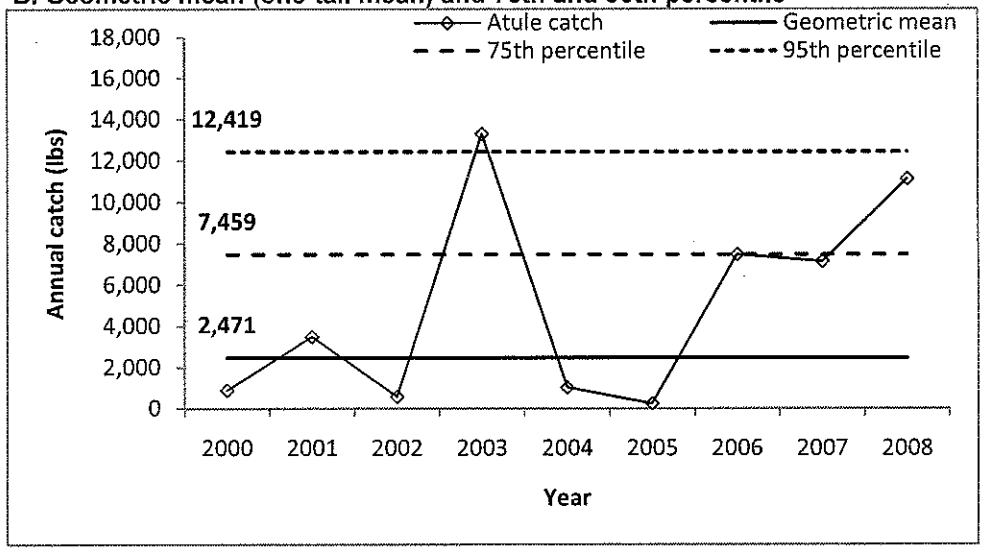
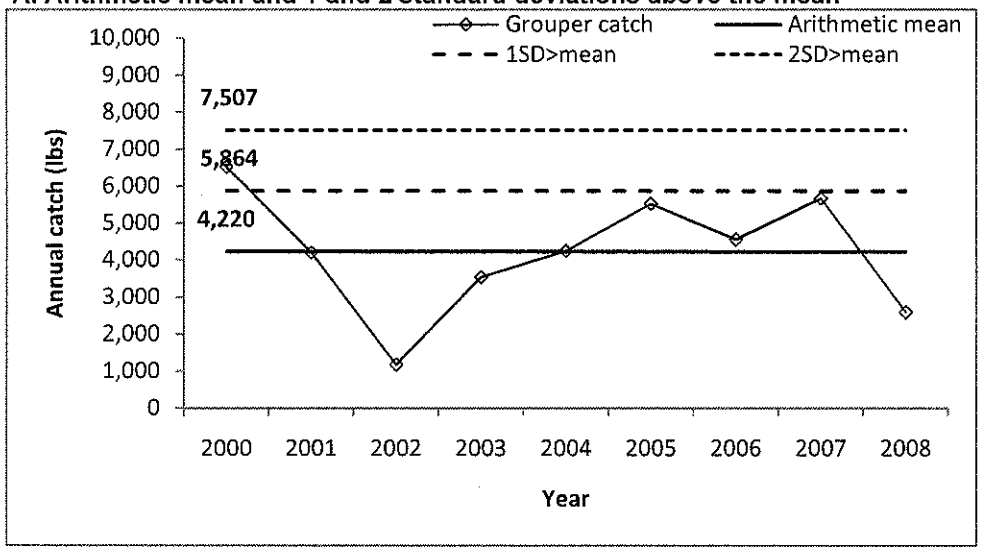


Figure 35. Temporal trend in annual catch of Serranidae (groupers) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

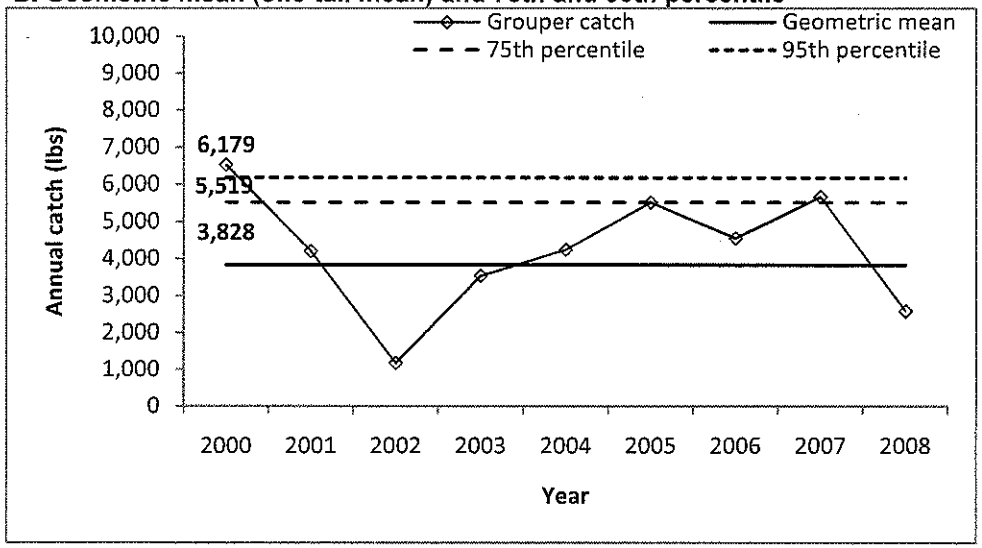
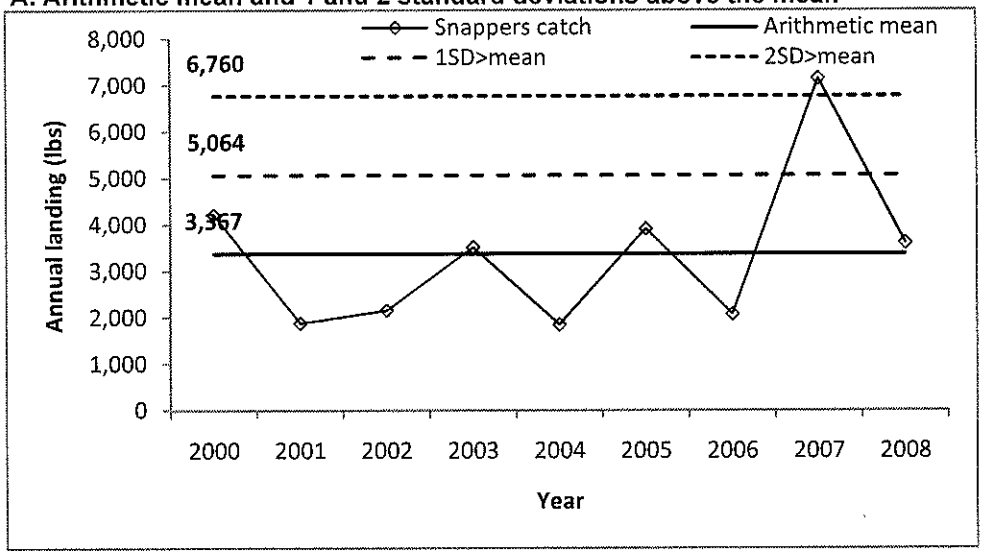


Figure 36. Temporal trend in annual catch of Lutjanidae (snappers) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

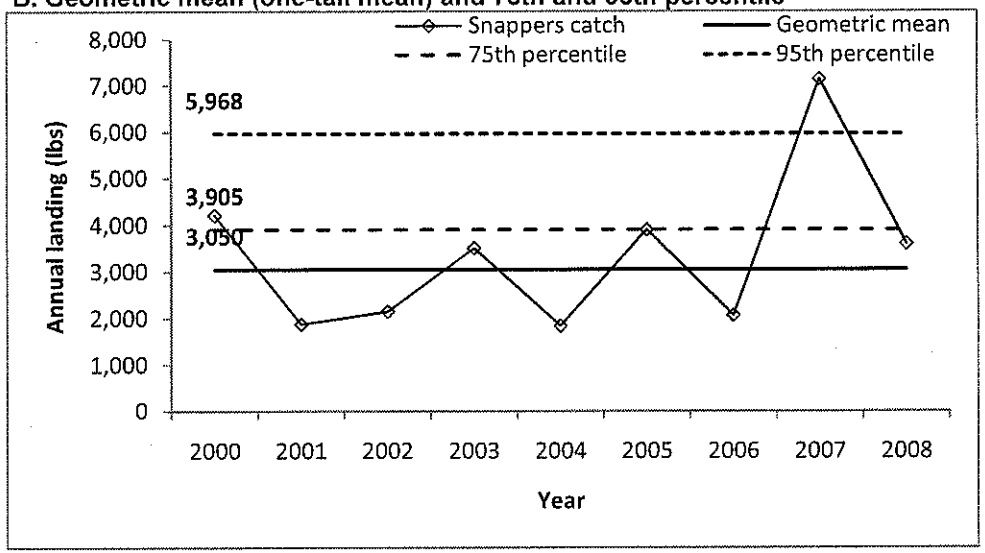
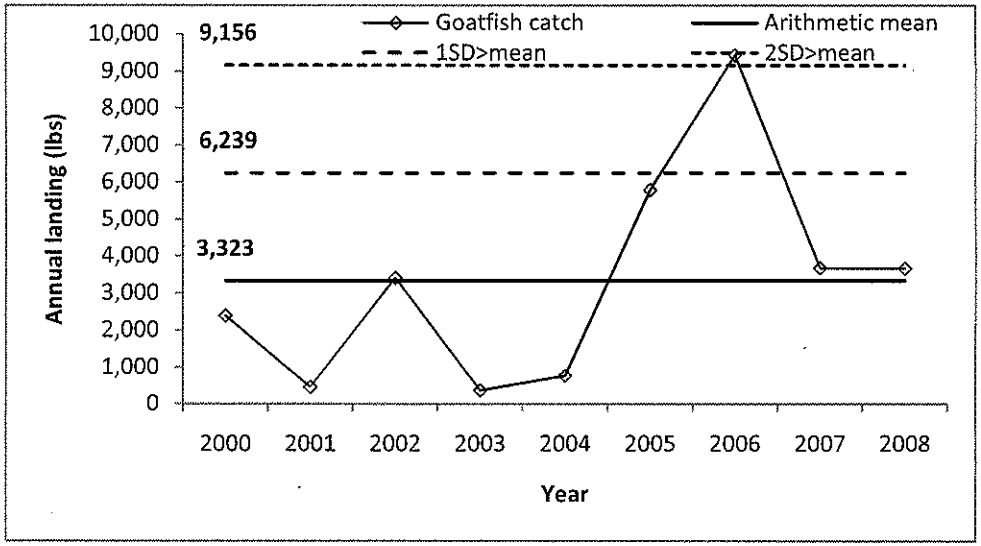


Figure 37. Temporal trend in annual catch of Mullidae (goatfish) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

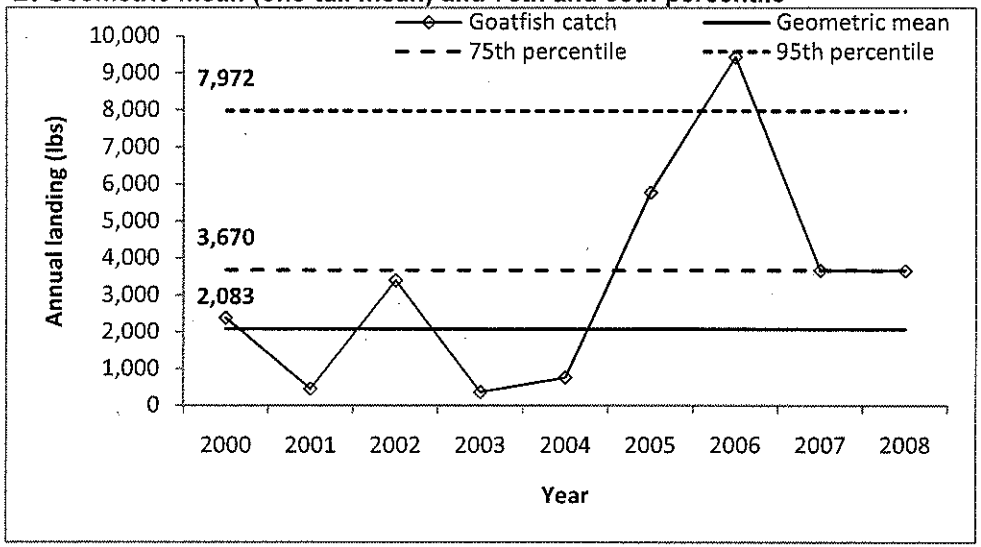
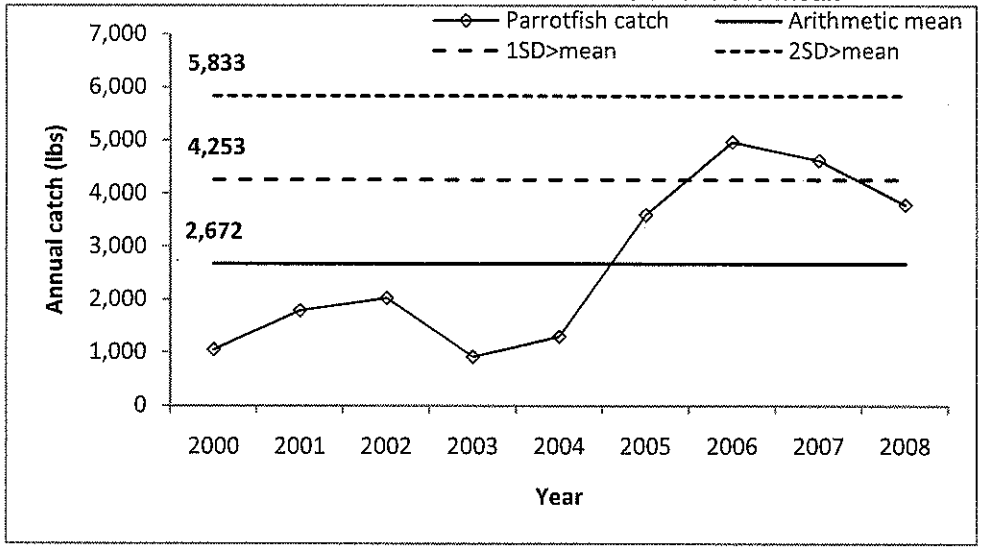


Figure 38. Temporal trend in annual catch of Scaridae (parrotfish except Bolbometopon muricatum) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

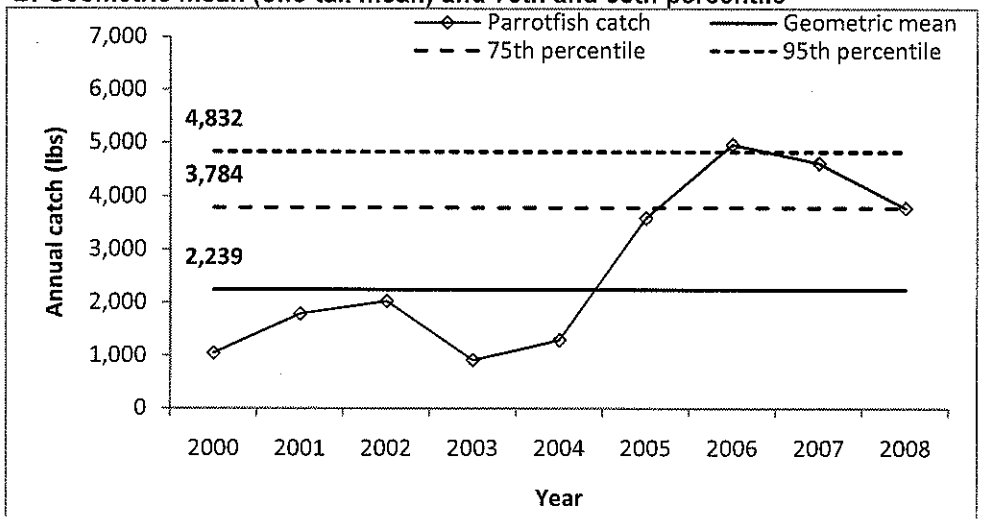
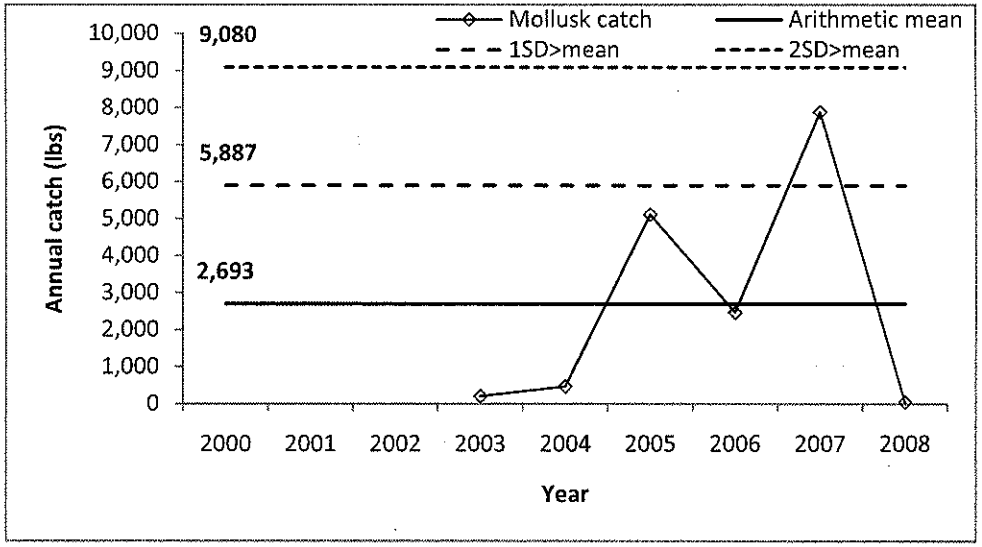


Figure 39. Temporal trend in annual catch of mollusks in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

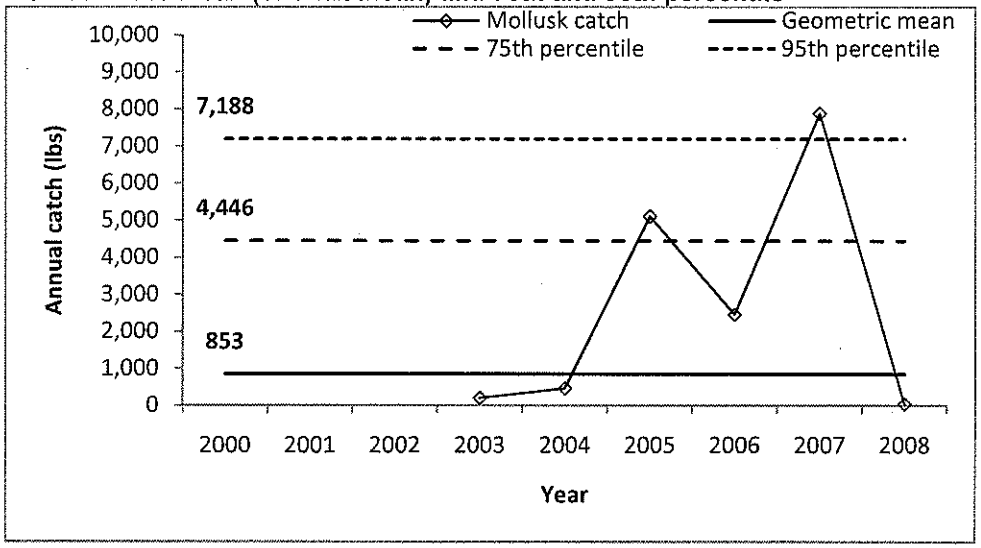
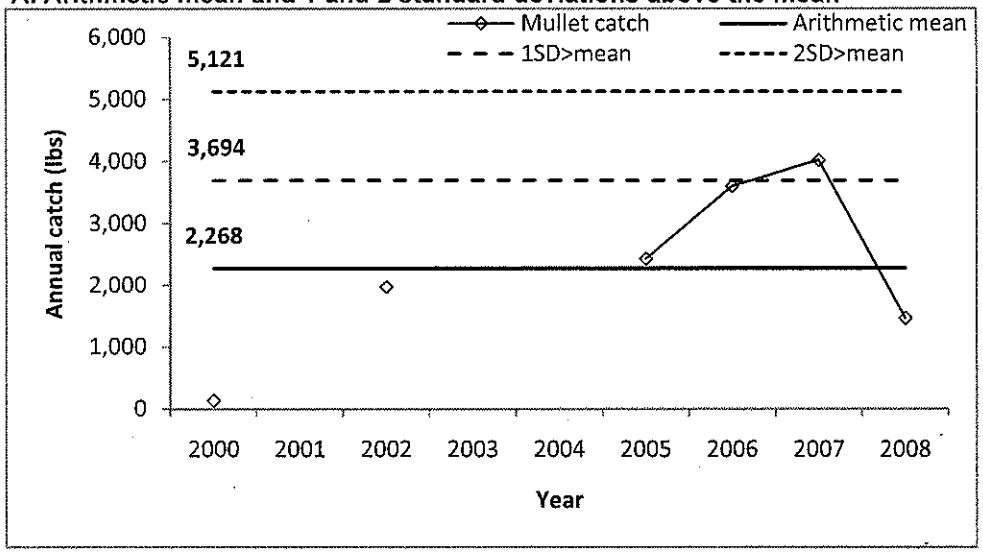


Figure 40. Temporal trend in annual catch of Mugilidae (mullets) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

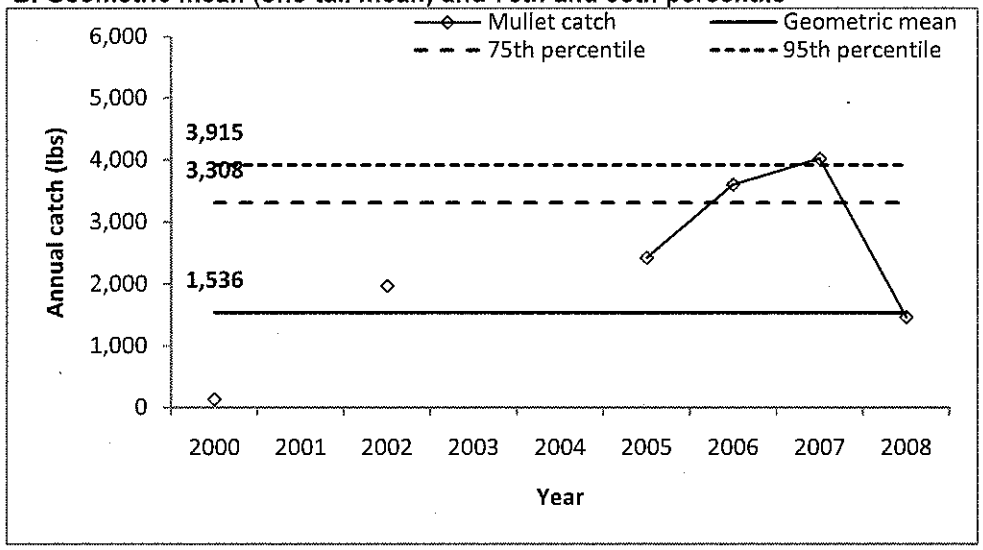
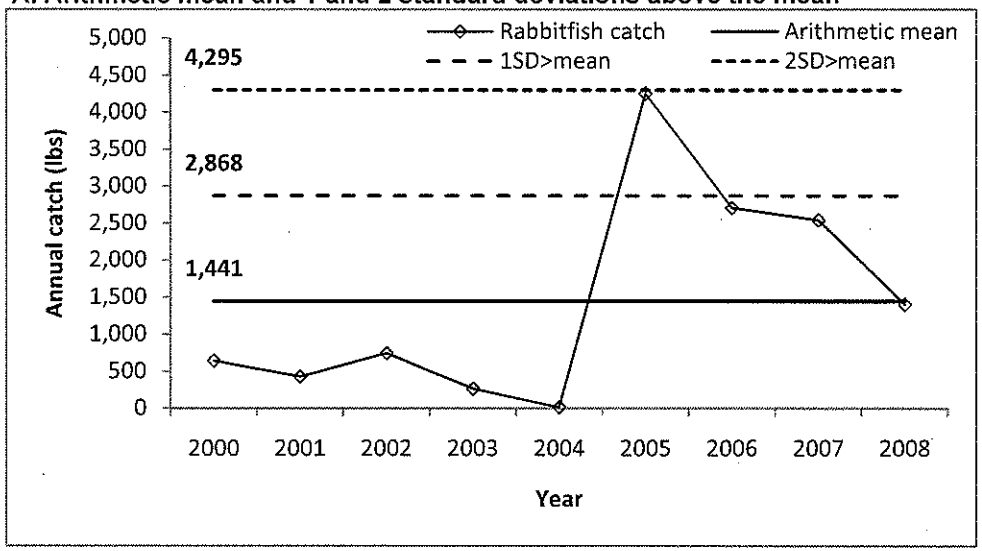


Figure 41. Temporal trend in annual catch of Siganidae (rabbitfish) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

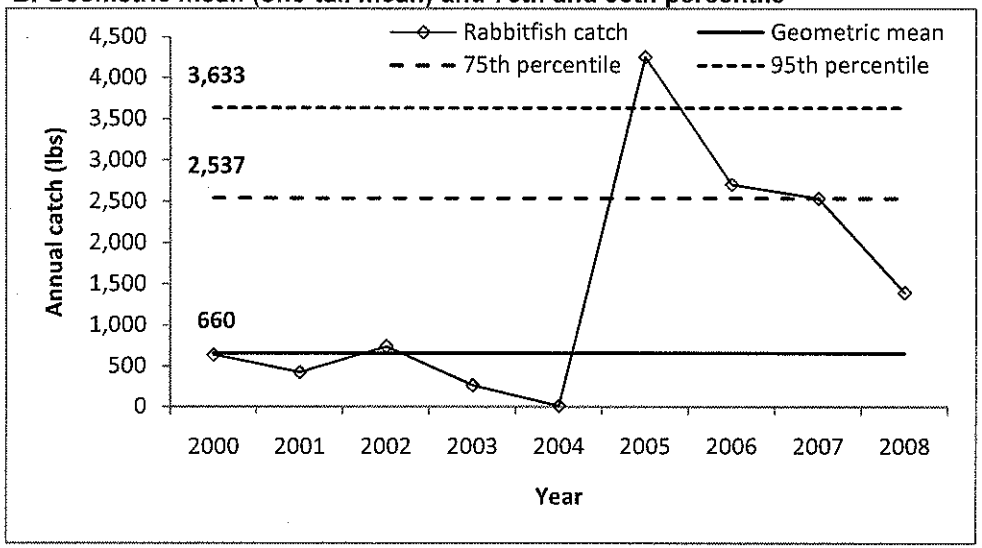
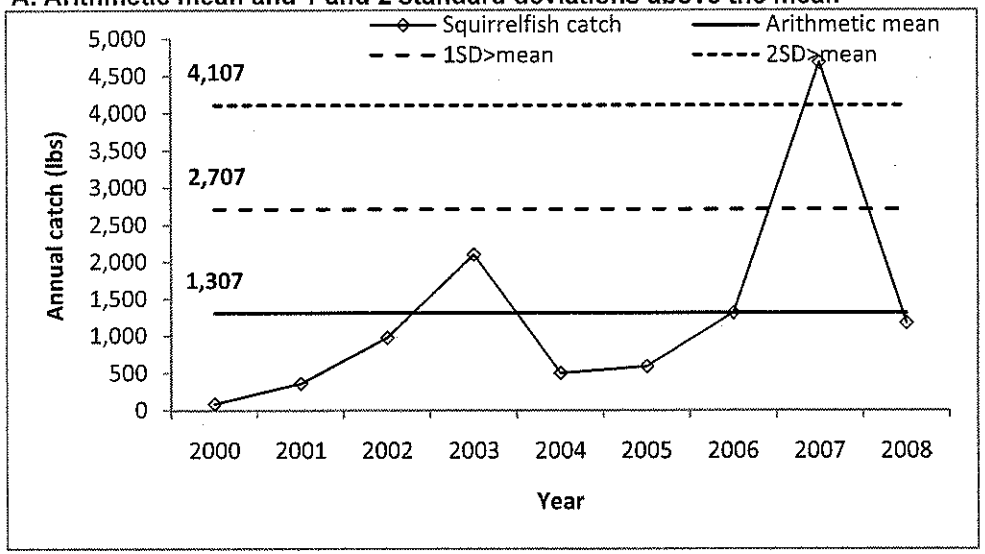


Figure 42. Temporal trend in annual catch of Holocentridae (squirrelfish) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

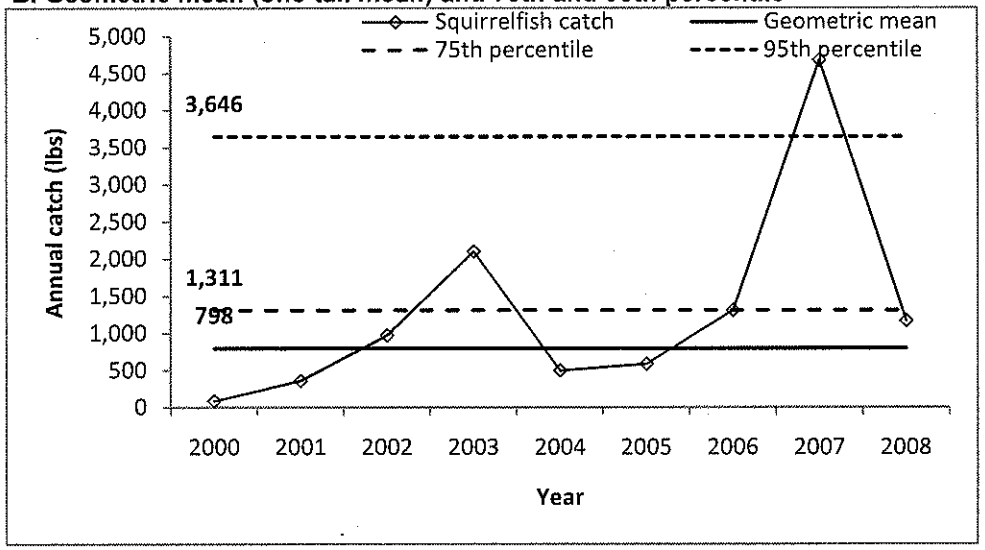
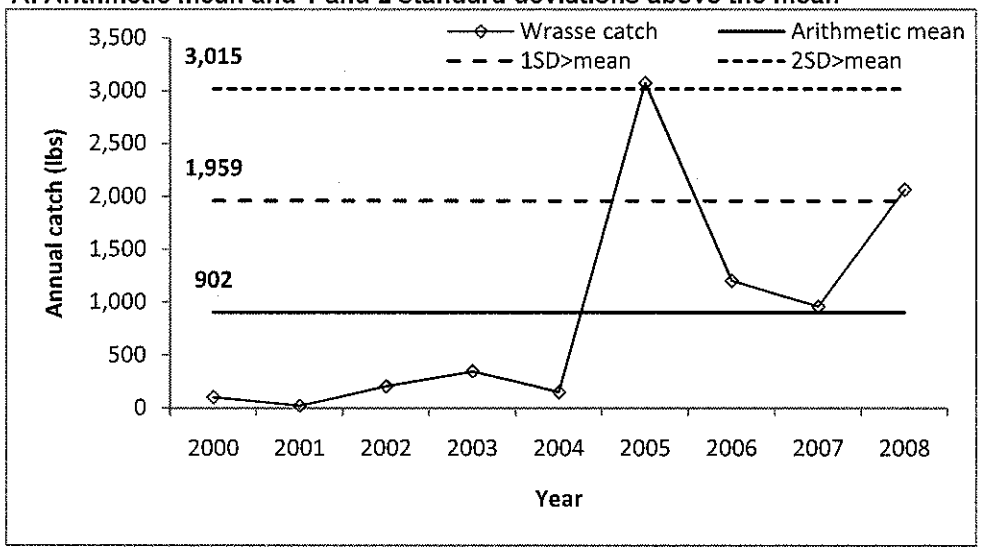


Figure 43. Temporal trend in annual catch of Labridae (wrasses except Cheilinus undulatus) in CNMI showing 2 types of central tendencies and variations

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

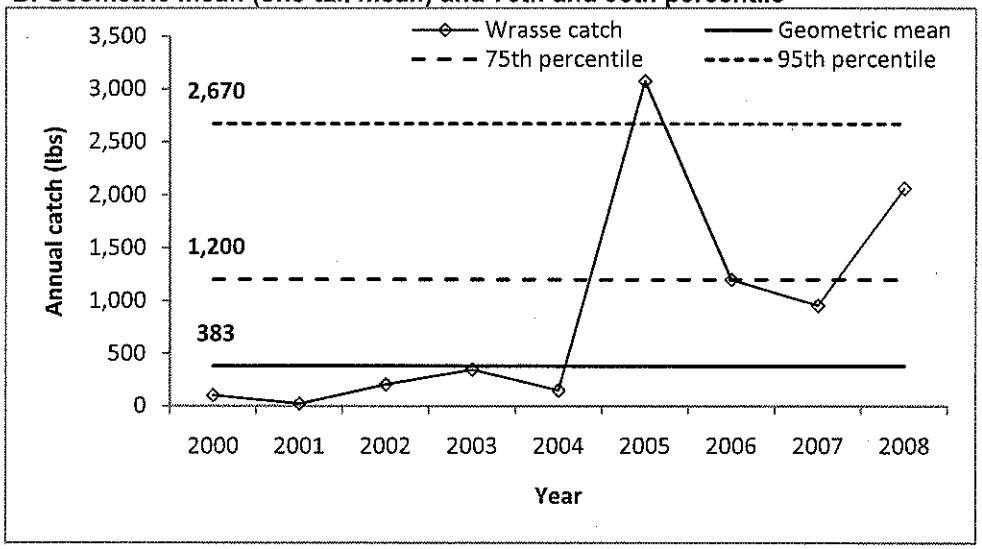
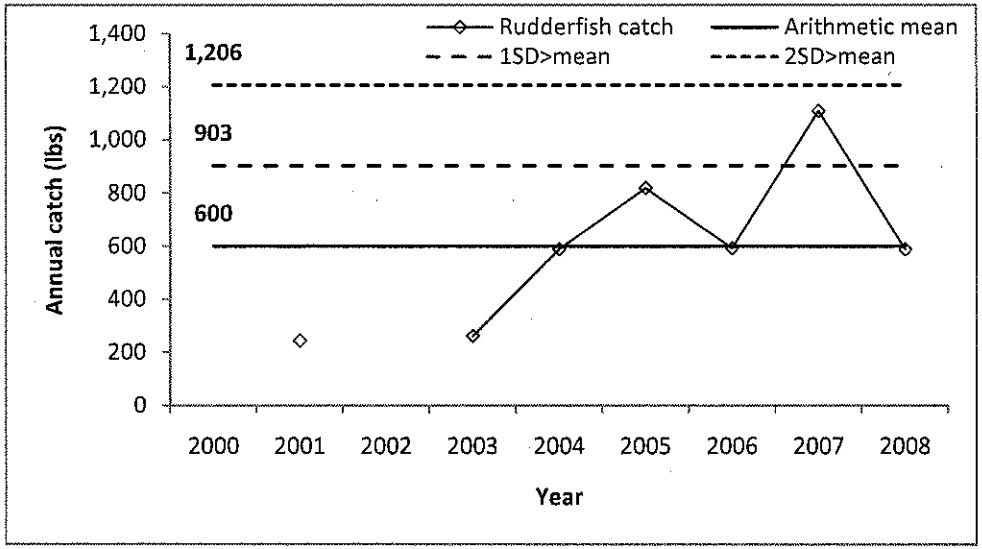


Figure 44. Temporal trend in annual catch of Kyphosidae (rudderfish) in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

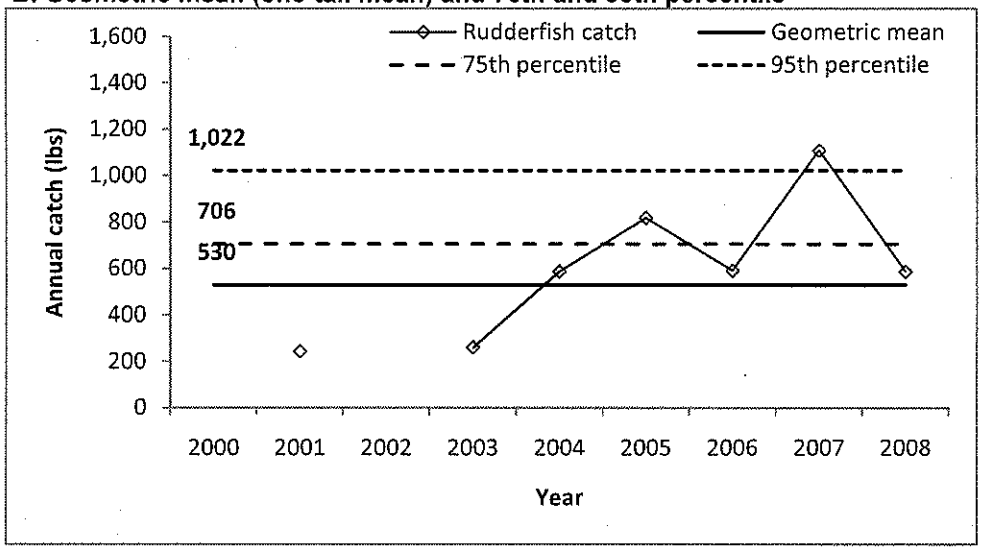
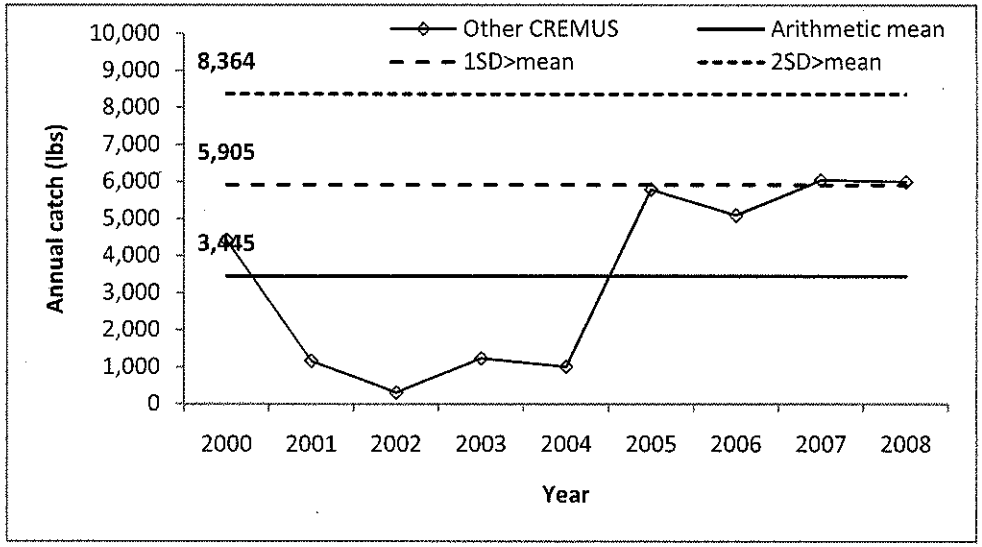


Figure 45. Temporal trend in annual catch of other CREMUS species assemblage in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

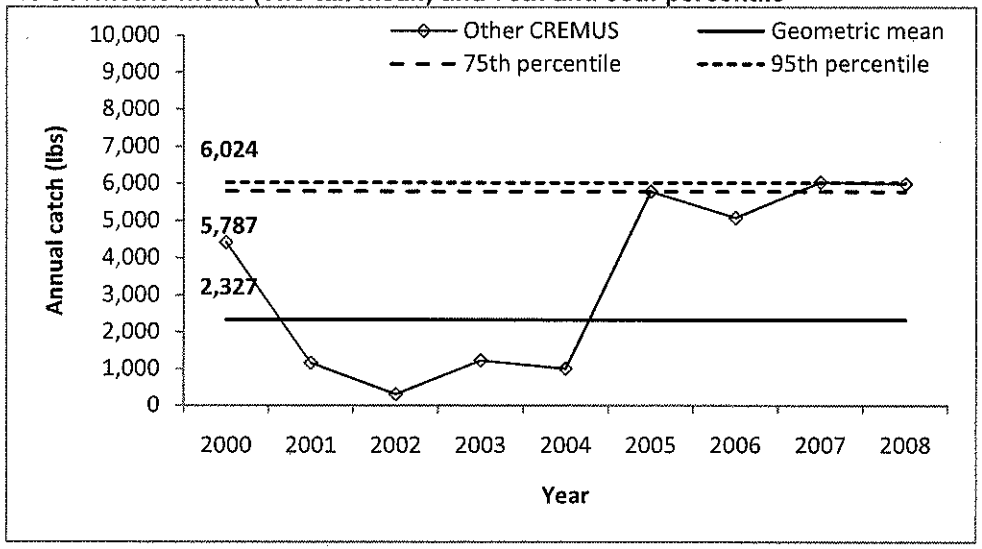
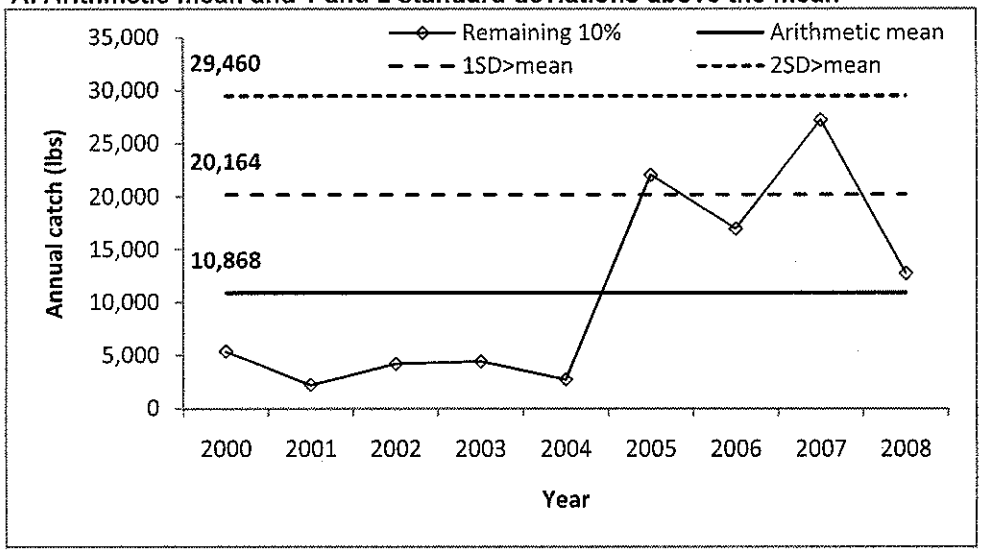
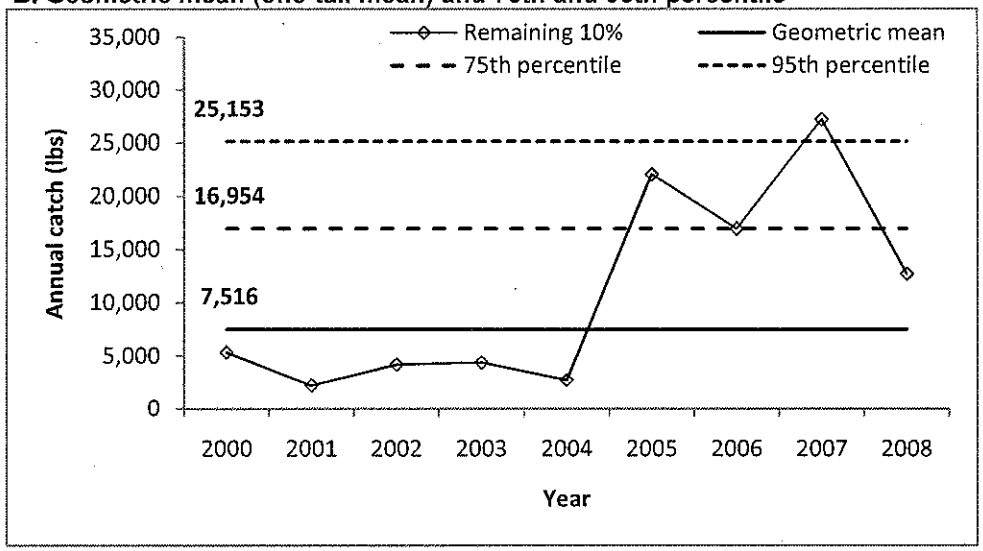


Figure 46. Temporal trend in annual catch of the remaining 10% of the CREMUS catch in CNMI showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile



LIST OF ALTERNATIVES FOR ACL SPECIFICATION IN THE CORAL REEF FISHERY IN GUAM

Alternative 1.A. No Action

Alternative 1.B.: All CREMUS groupings aggregated

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
ALL CREMUS	383,486	140,186	523,671	663,857	359,228	482,319	576,494

Alternative 1.C.: Top 90% of CREMUS landing and rest of 10% binned together

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
	NOT APPLICABLE FOR GUAM DATA				NOT APPLICABLE FOR GUAM DATA		

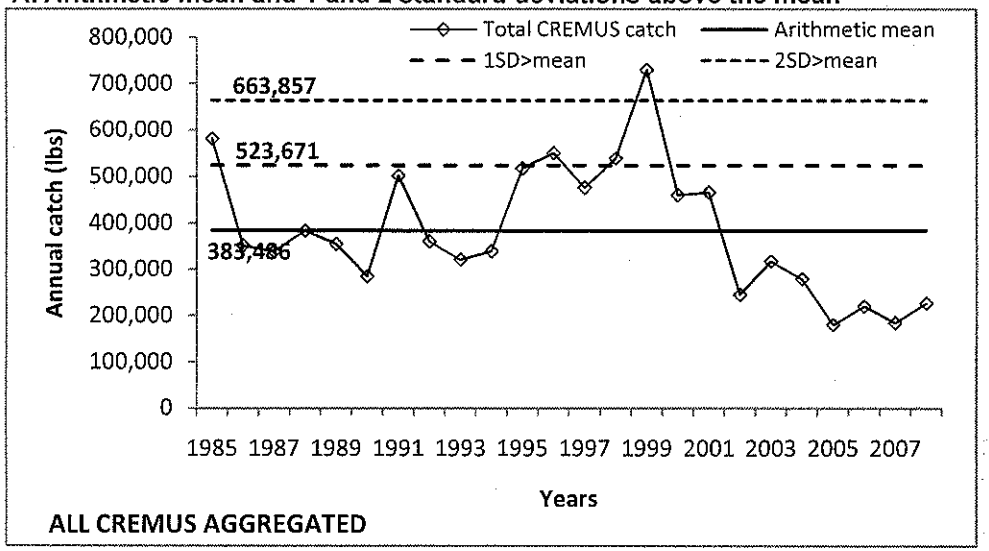
Alternative 1.D.: Individual CREMUS groupings

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Surgeonfish	59,261	23,308	82,569	105,877	55,015	70,702	101,923
Jacks	38,755	15,313	54,069	69,382	36,360	45,377	60,072
Atule	36,143	38,937	75,081	114,018	18,473	56,514	115,064
Emperor	31,554	12,601	44,155	56,756	29,026	38,720	52,643
Parrotfish*	22,146	10,501	32,646	43,147	19,574	28,649	36,477
Goatfish	20,916	9,981	30,897	40,878	18,423	25,367	40,462
Mollusk	20,812	18,126	38,938	57,065	16,788	21,941	43,294
Rabbitfish	20,329	8,321	28,650	36,972	18,560	26,120	29,910
Snappers	14,241	4,854	19,095	23,949	13,413	17,726	19,807
Groupers	14,040	5,754	19,794	25,548	12,894	17,958	21,653
Mullets	10,598	7,533	18,132	25,665	7,840	15,032	23,781
Rudderfish	9,901	5,582	15,483	21,064	8,457	13,247	19,011
Crustacean	6,134	3,747	9,880	13,627	5,203	7,890	12,760
Squirrelfish	6,086	3,771	9,856	13,627	5,135	8,300	12,390
Algae	5,159	8,387	13,546	21,933	1,555	5,329	21,610
Wrasse	3,855	2,613	6,469	9,082	3,001	5,195	8,184
Sp. of concern***	8,113	7,362	15,476	22,838	5,582	8,673	22,422
Other CREMUS****	55,657	30,700	86,357	117,057	47,797	83,214	109,806

NOTE:
* excludes Bolbometopon muricatum (bumphead parrotfish)
** excludes Cheilinus undulatus (humphead wrasse)
*** includes reef sharks, C. undulatus, B. muricatum
**** includes uni'd fish and other sp. and comprise the remaining 15% of the CREMUS catch

Figure 47. Temporal trend in annual catch of all species listed under CREMUS in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

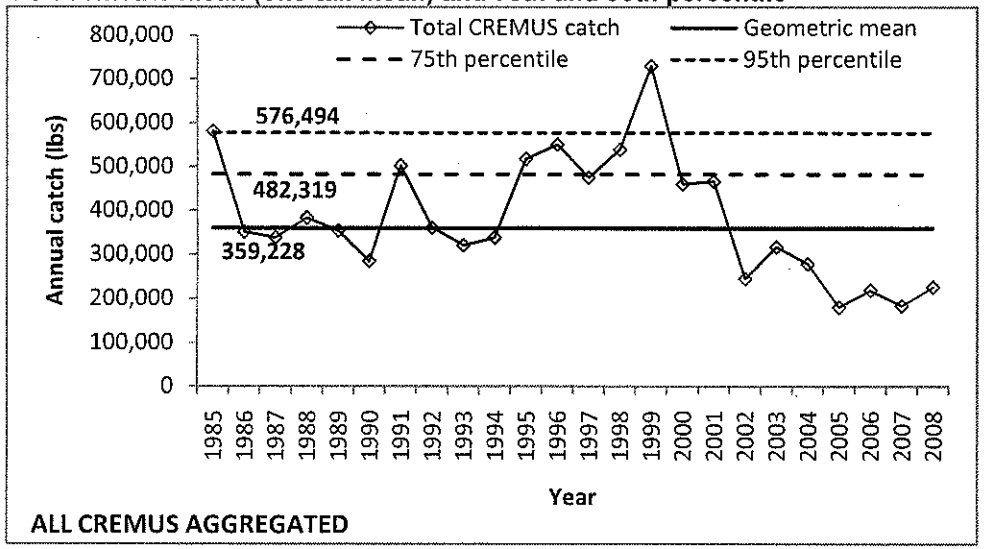
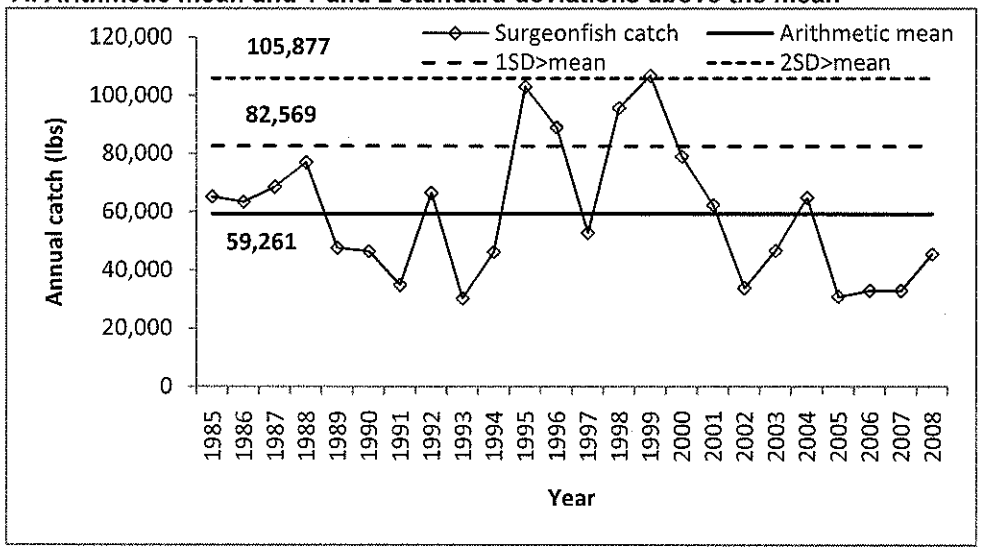


Figure 48. Temporal trend in annual catch of Acathuridae (surgeonfish) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

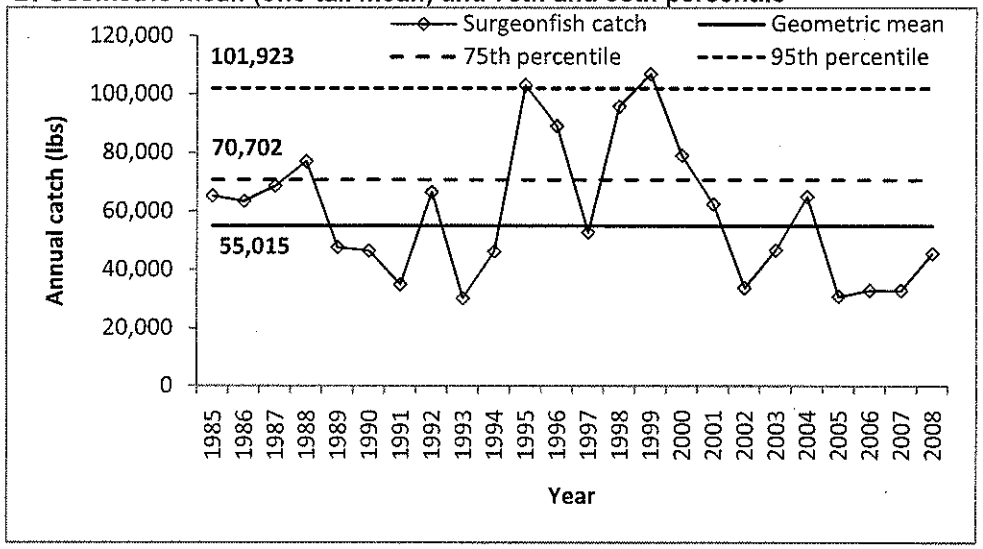
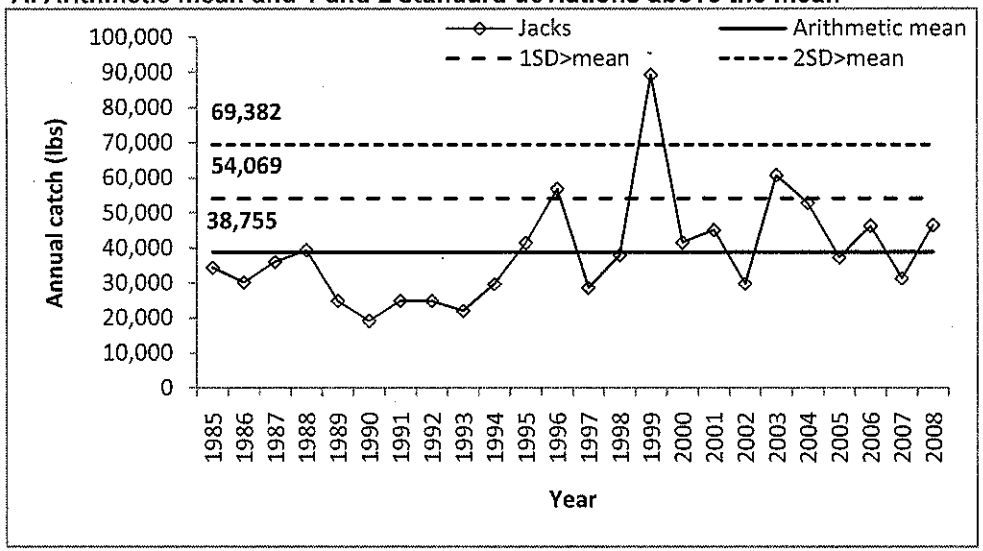


Figure 49. Temporal trend in annual catch of Carangidae (jacks) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

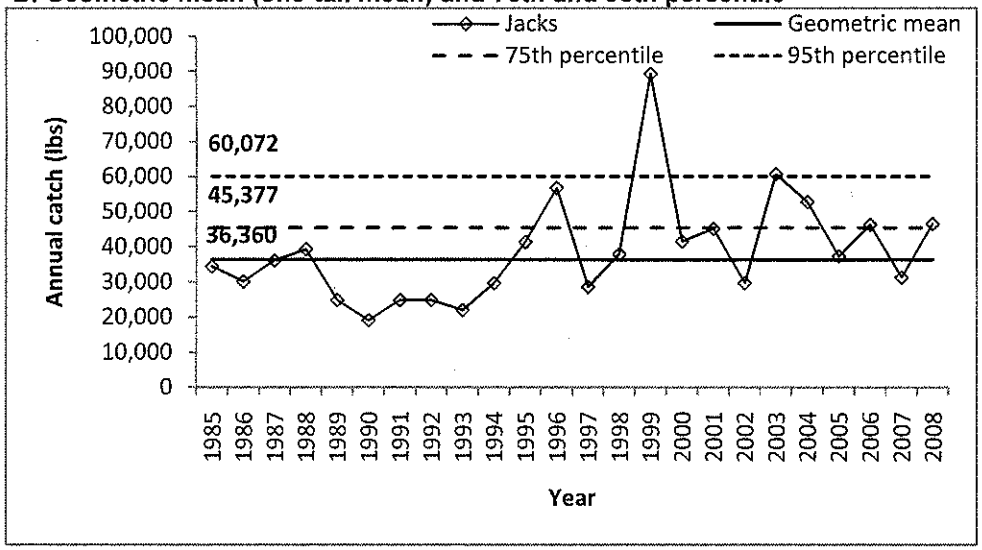
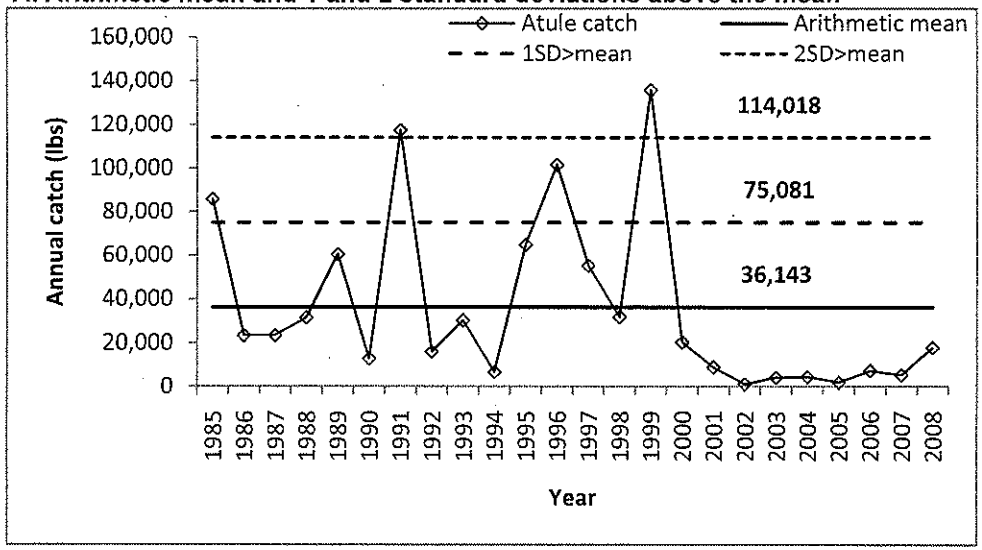


Figure 50. Temporal trend in annual catch of Selar crumenopthalmus (atule) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

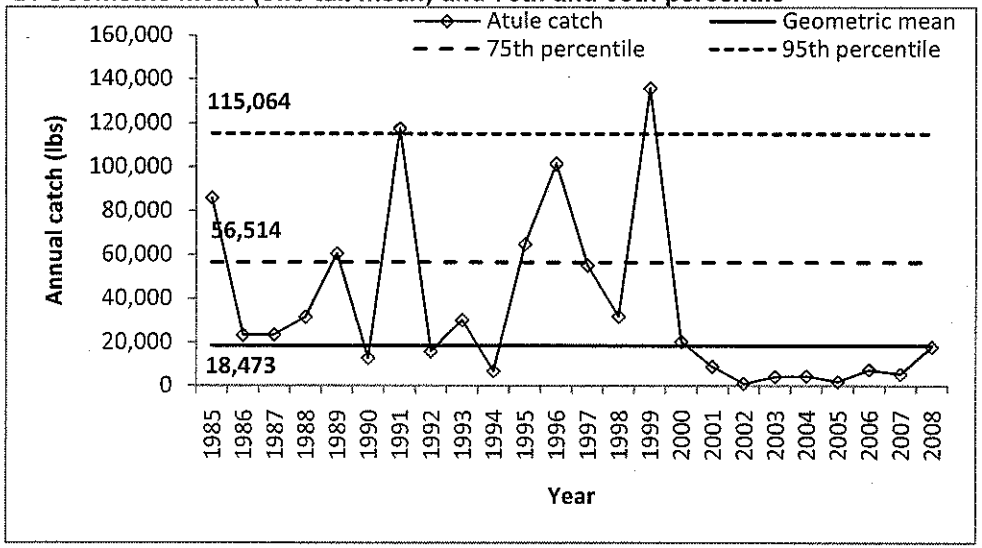
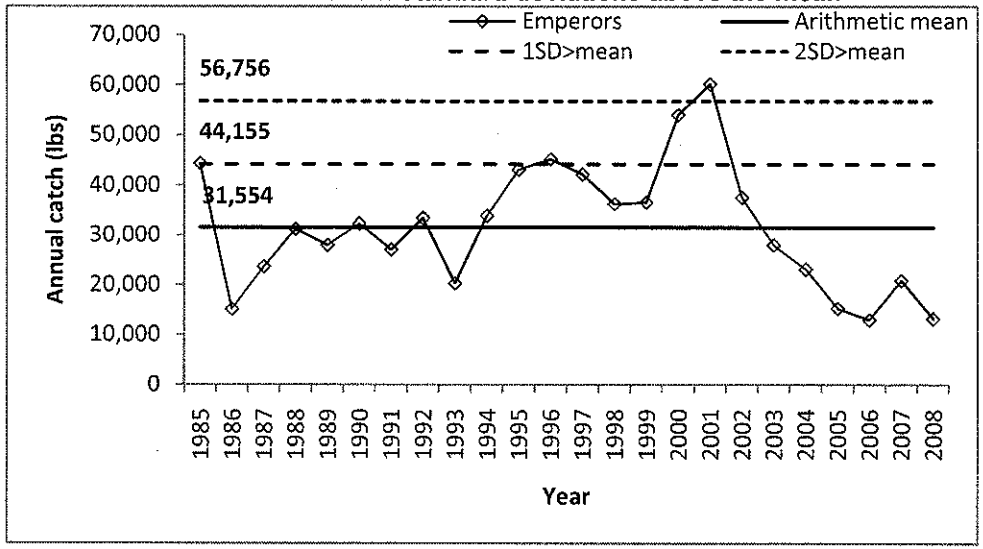


Figure 51. Temporal trend in annual catch of Lethrinidae (emperors) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

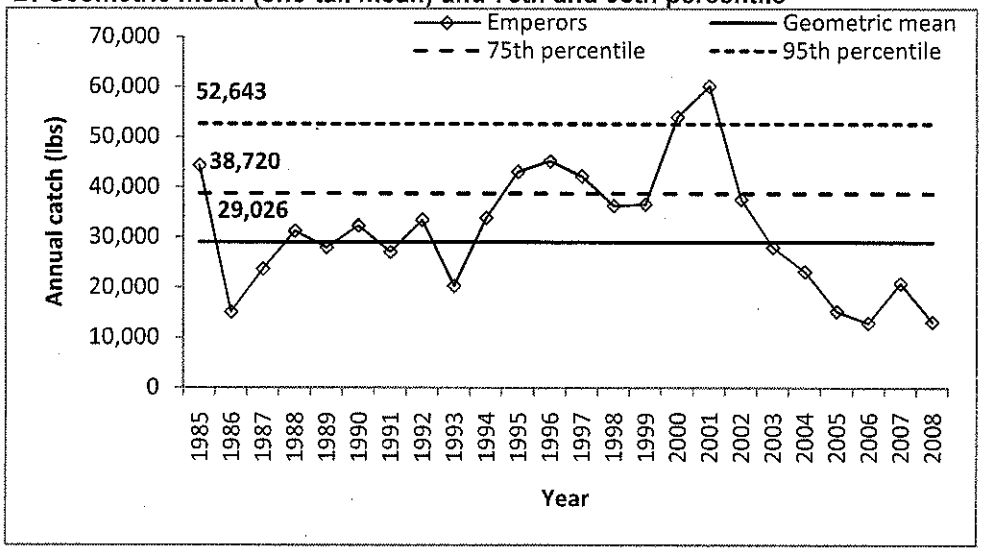
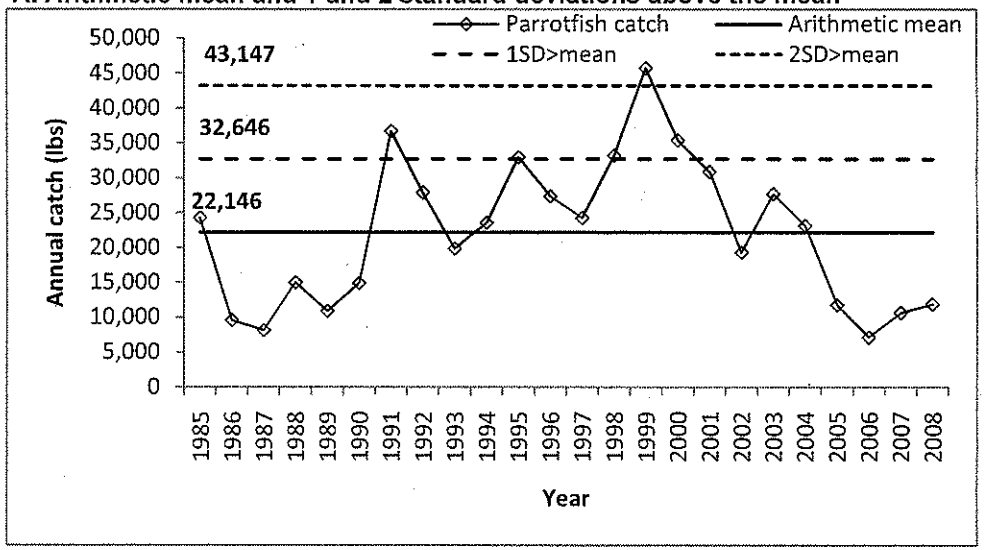


Figure 52. Temporal trend in annual catch of Scaridae (parrotfish except Bolbometopon muricatum) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

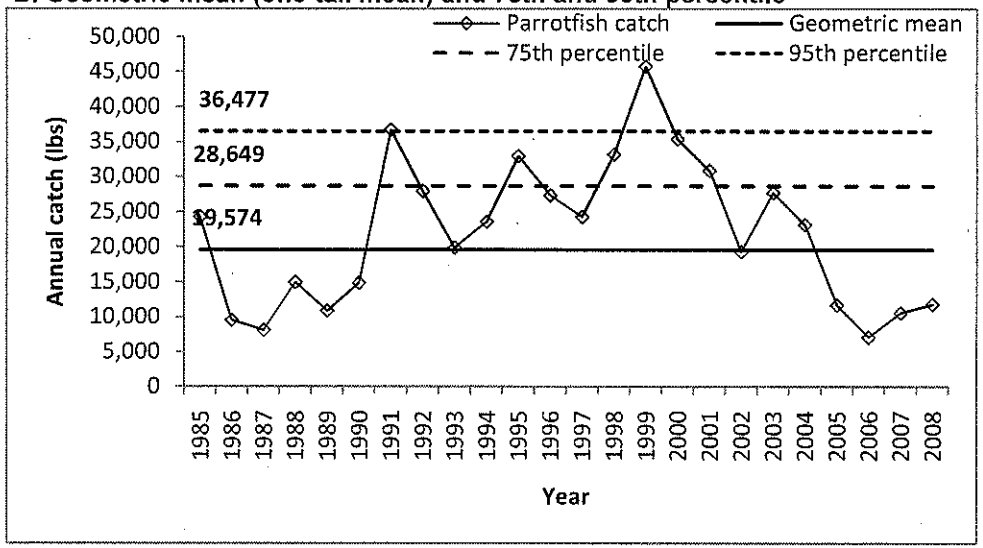
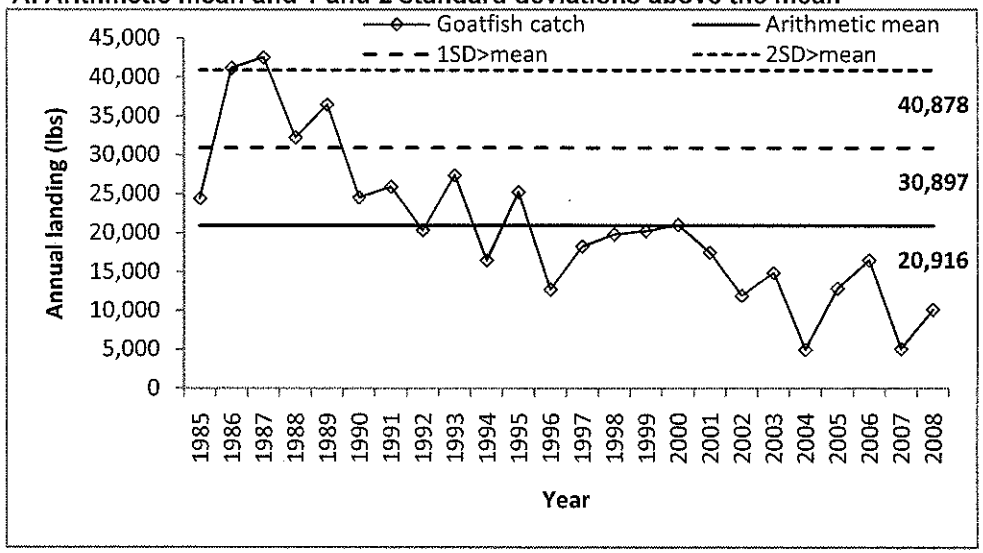


Figure 53. Temporal trend in annual catch of Mullidae (goatfish) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

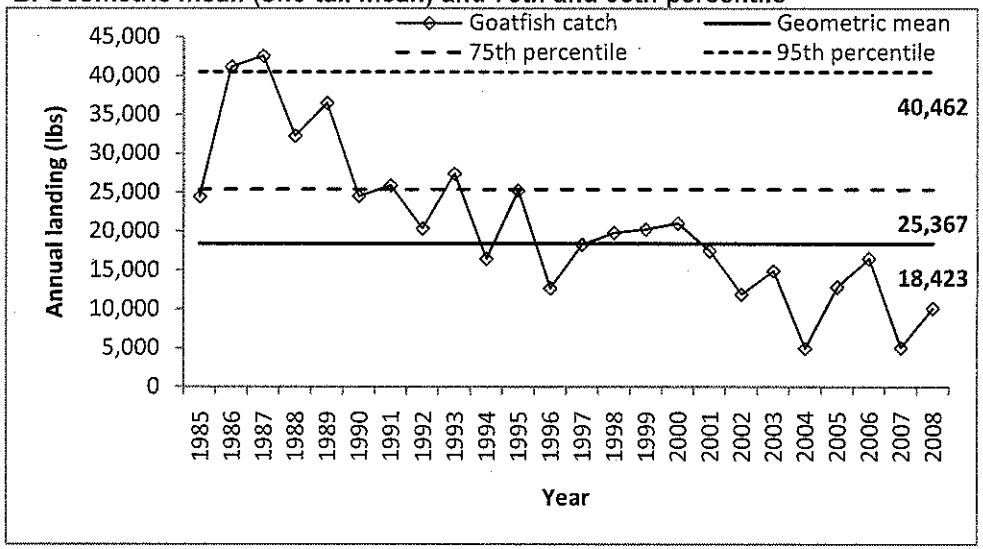
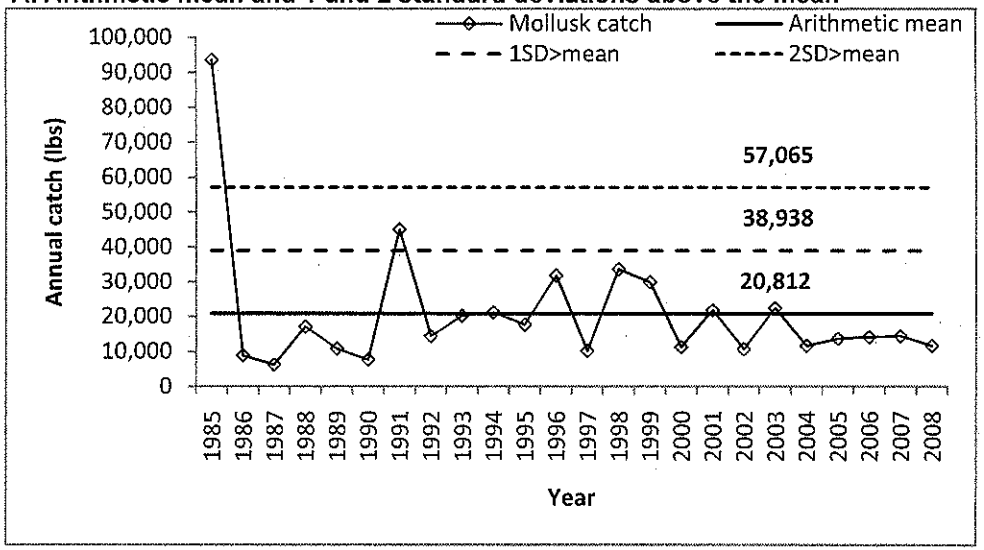


Figure 54. Temporal trend in annual catch of mollusks in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

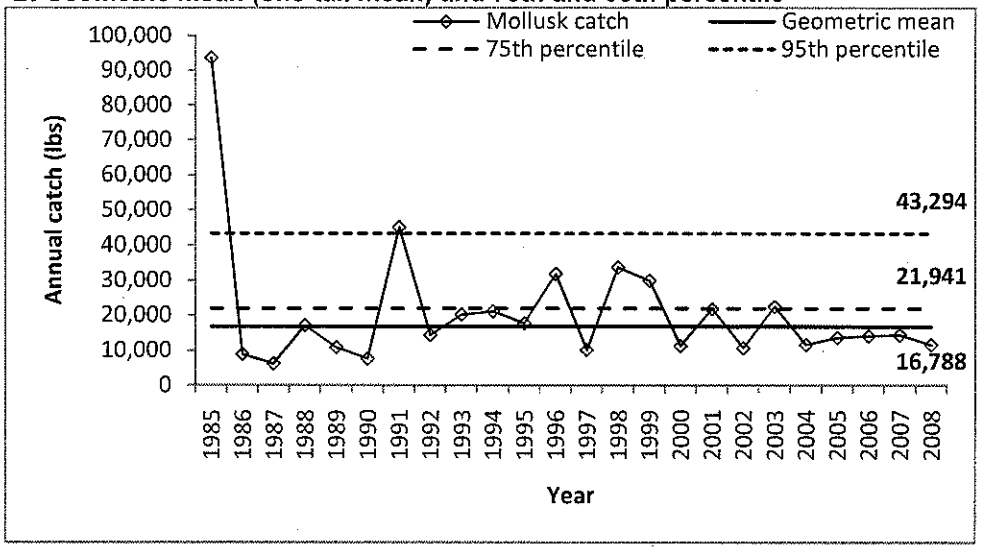
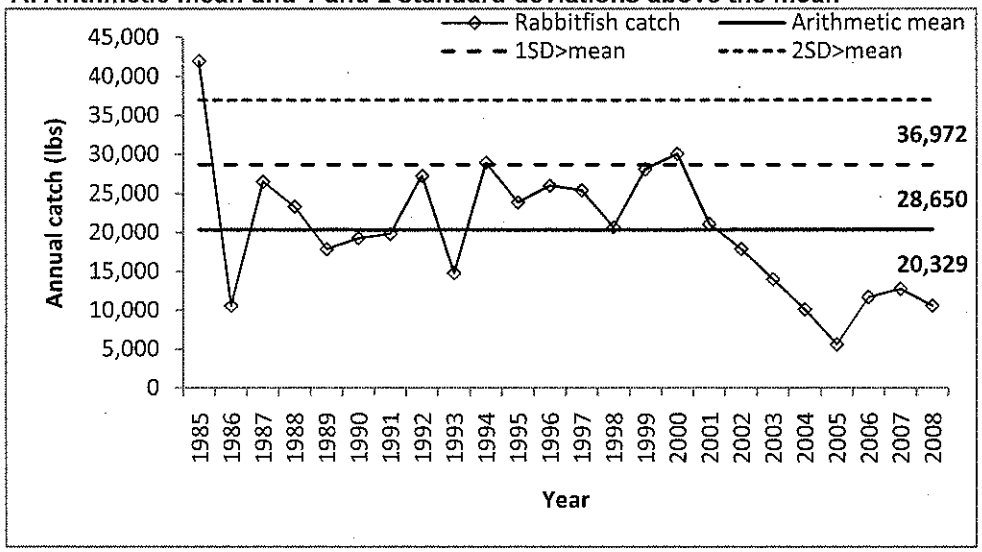


Figure 55. Temporal trend in annual catch of Siganidae (rabbitfish) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

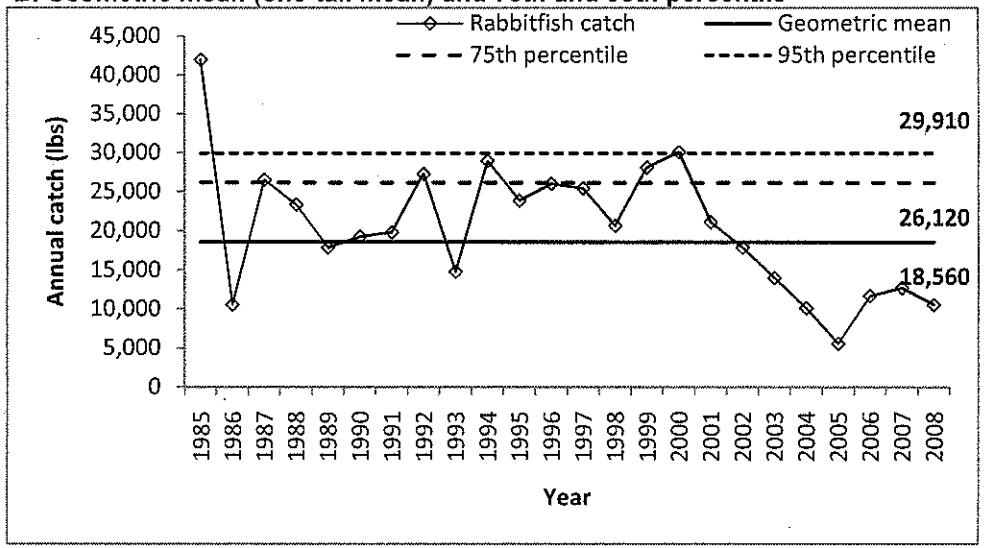
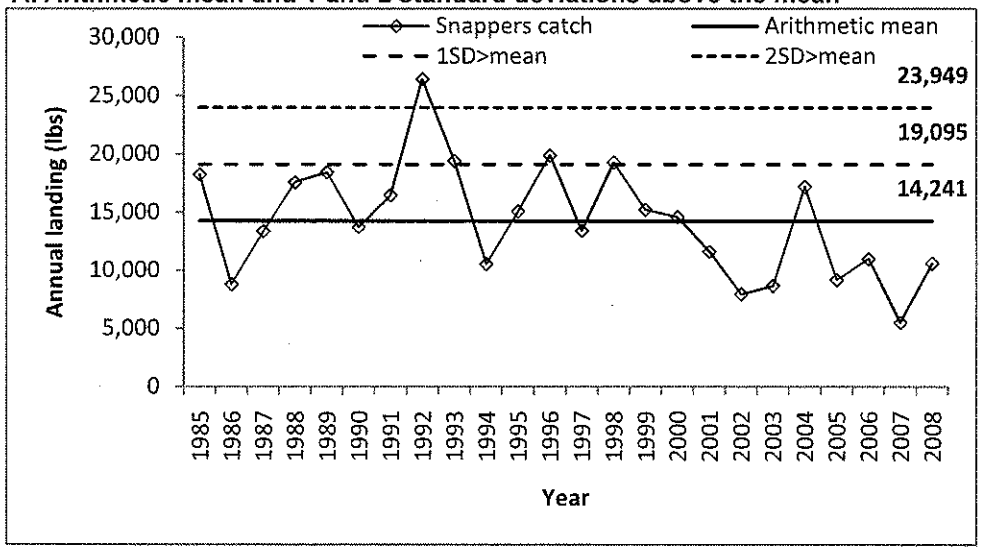


Figure 56. Temporal trend in annual catch of Lutjanidae (snappers) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

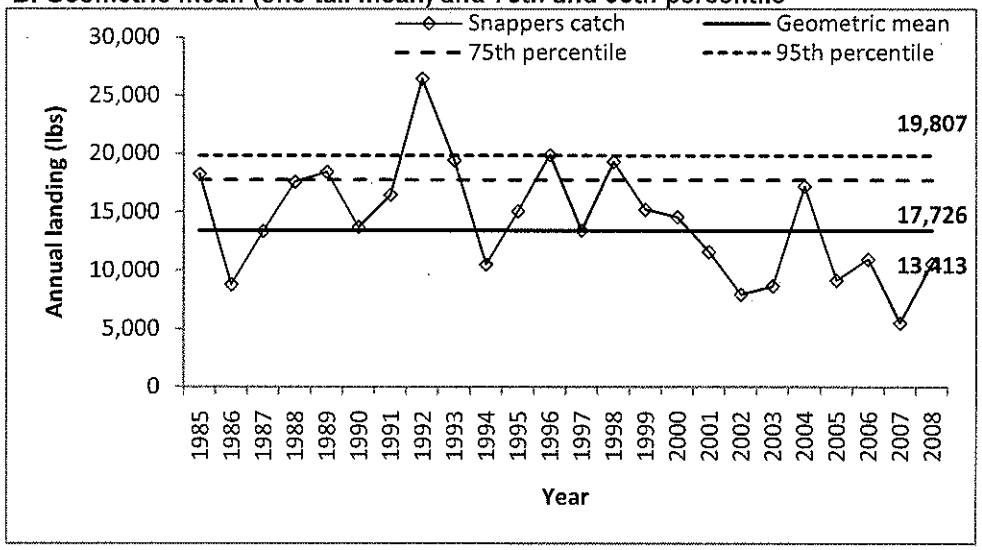
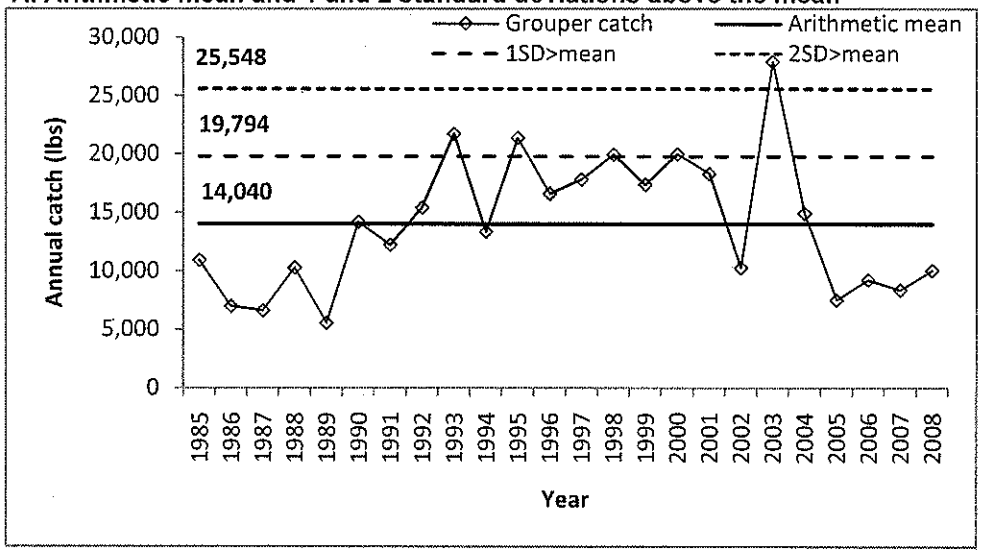


Figure 57. Temporal trend in annual catch of Serranidae (groupers) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

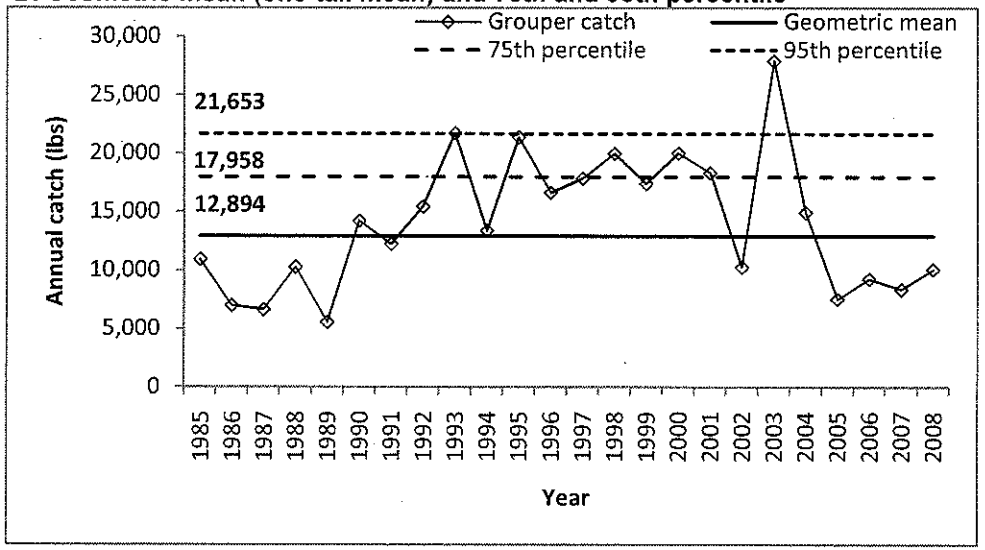
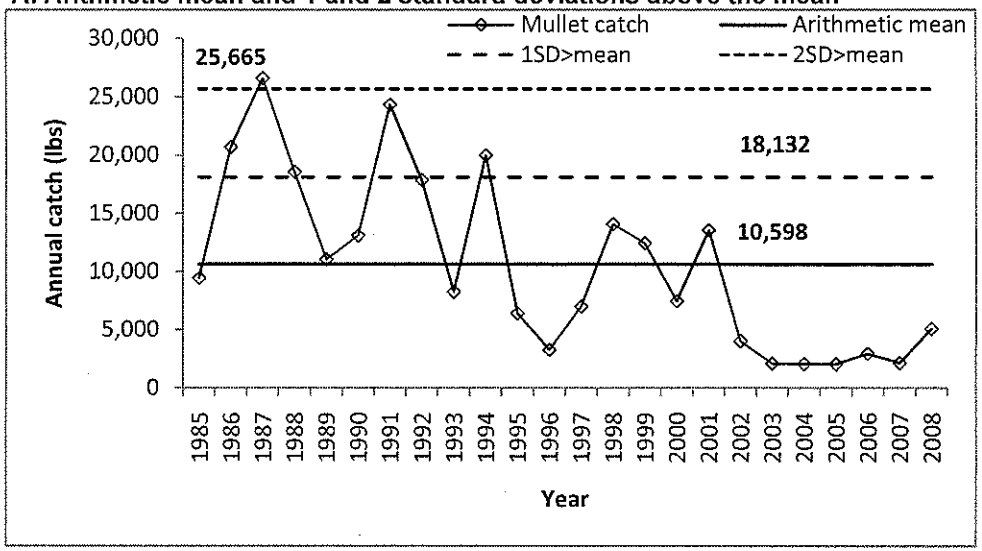


Figure 58. Temporal trend in annual catch of Mugilidae (mullets) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

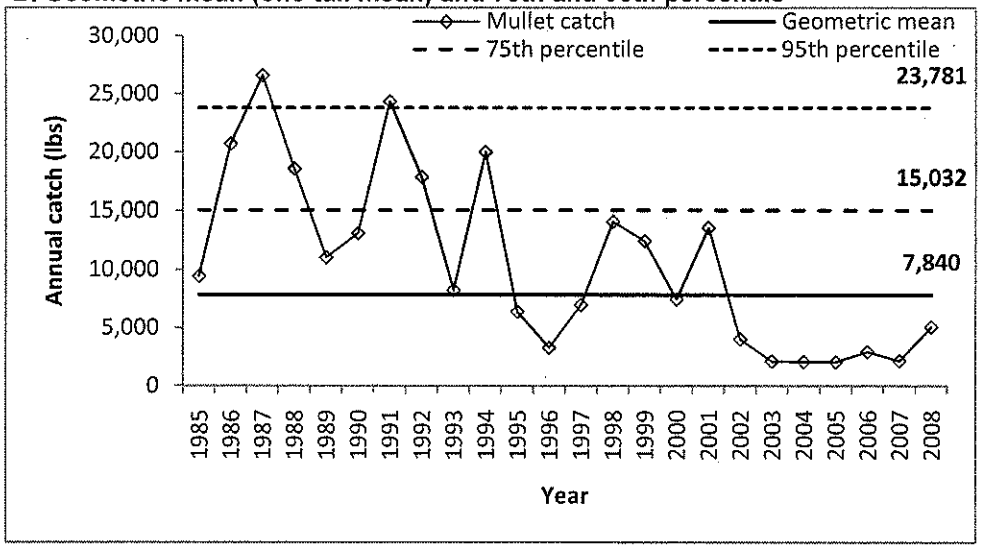
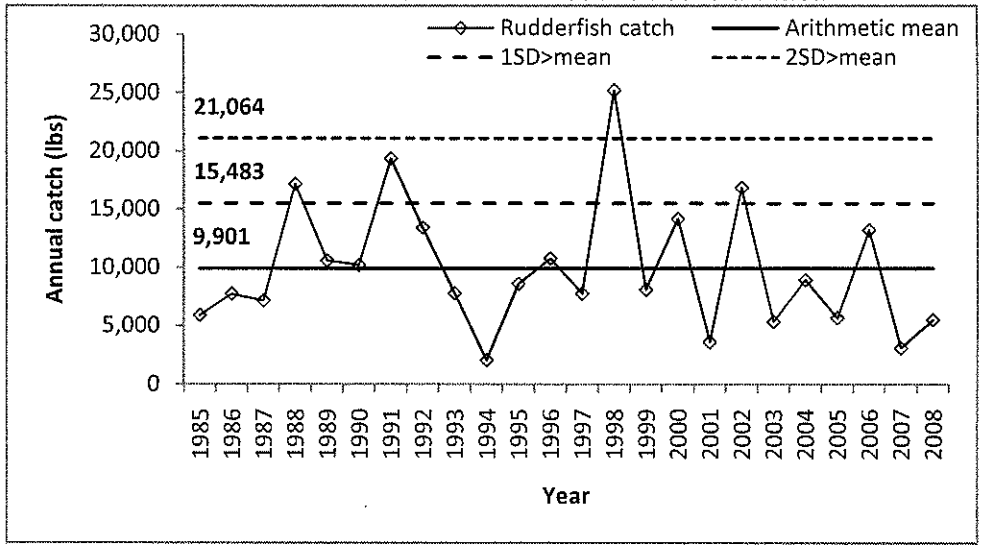


Figure 59. Temporal trend in annual catch of Kyphosidae (rudderfish) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

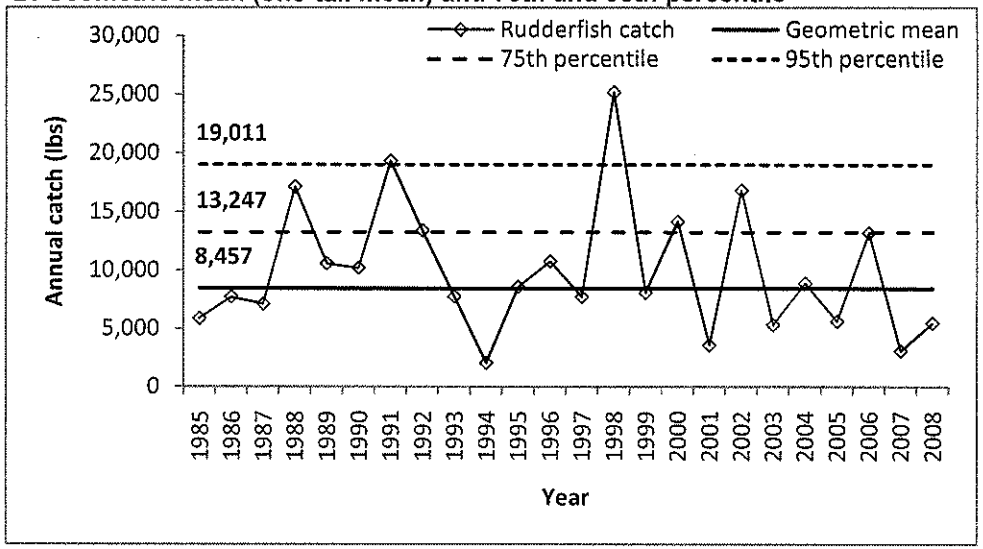
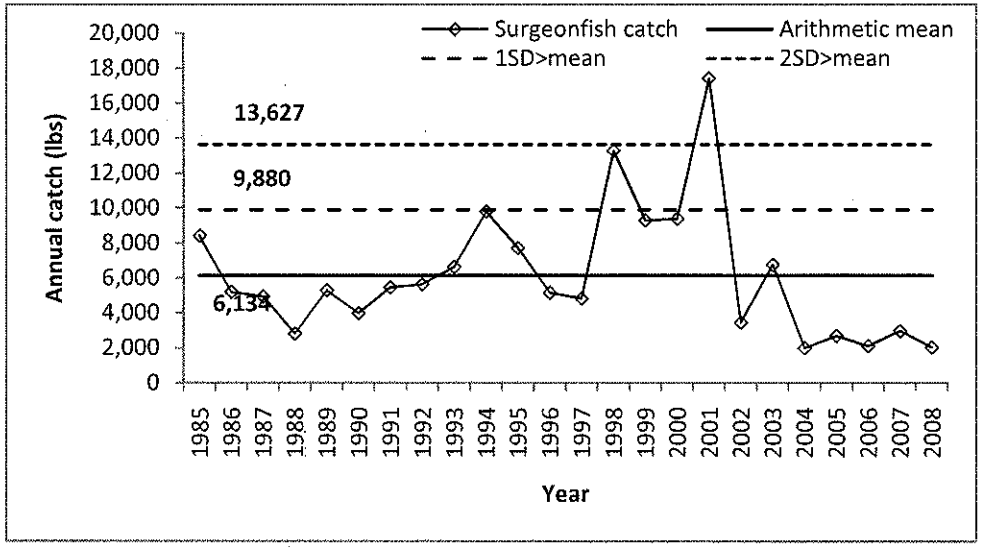


Figure 60. Temporal trend in annual catch of crustaceans in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

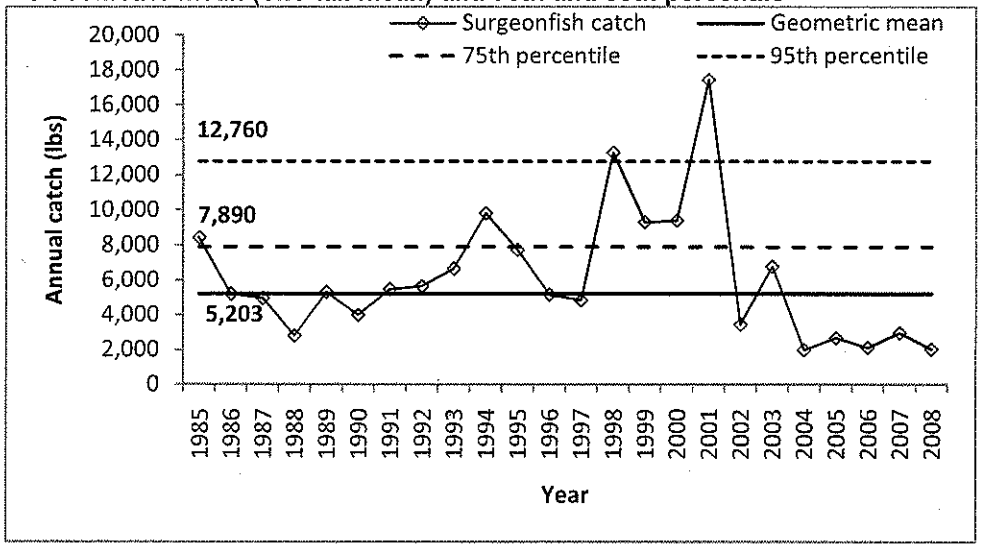
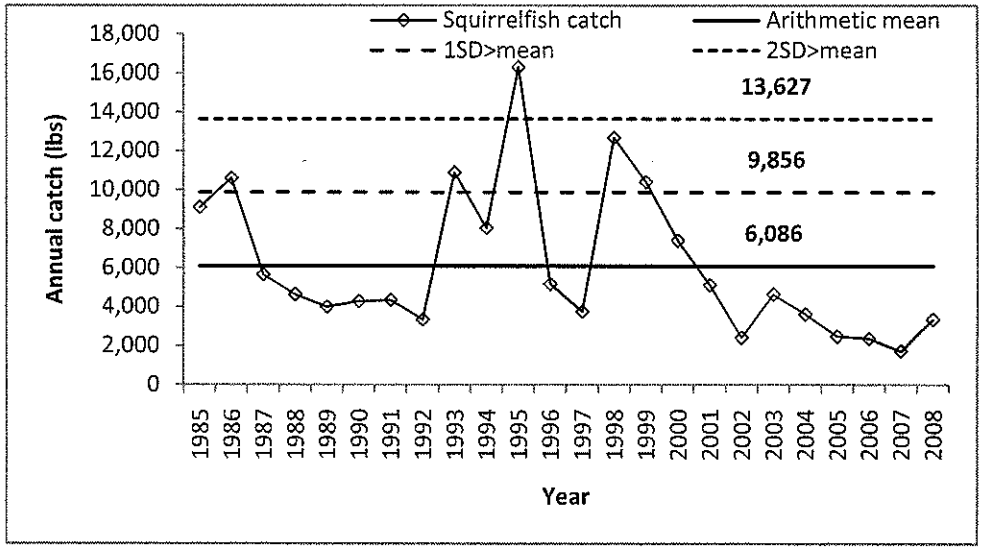


Figure 61. Temporal trend in annual catch of Holocentridae (squirrelfish) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

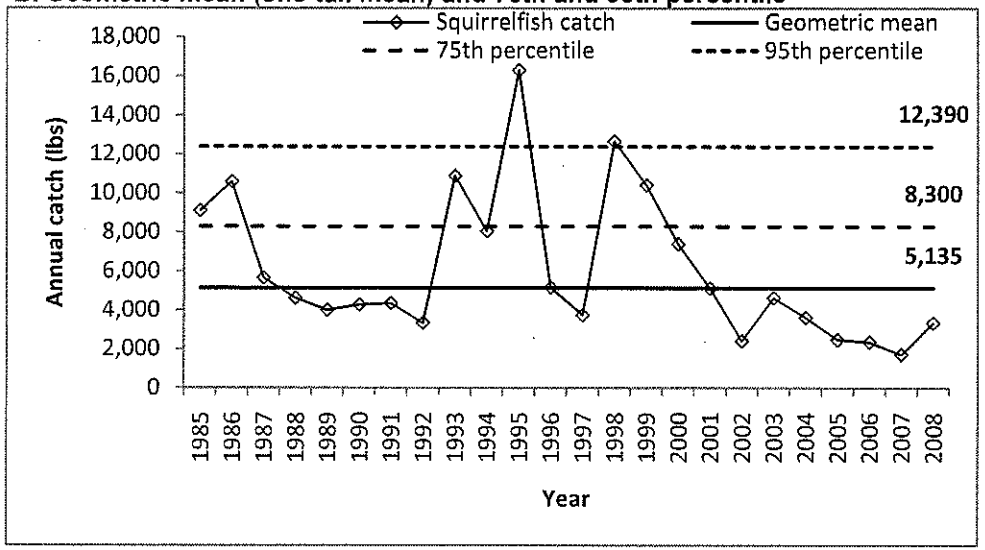
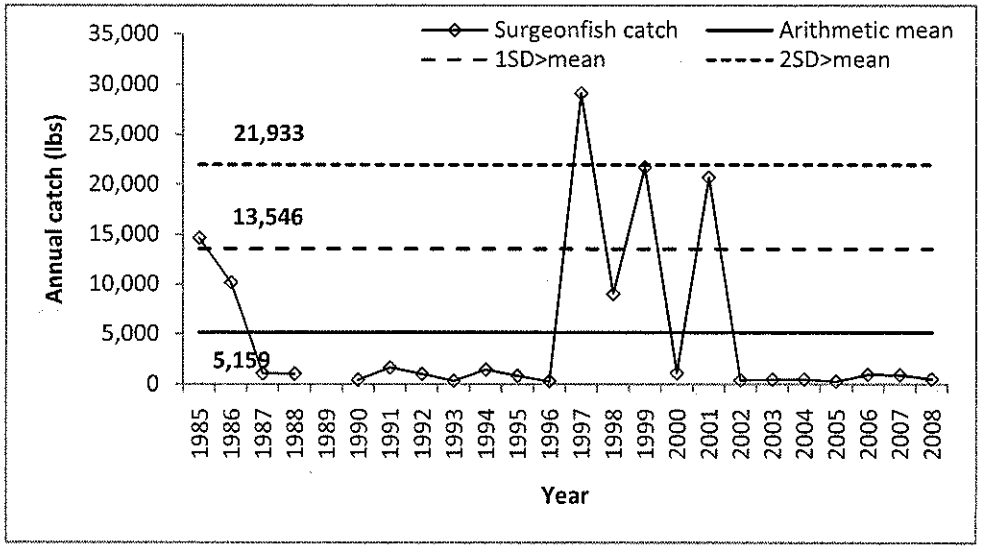


Figure 62. Temporal trend in annual catch of algae in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

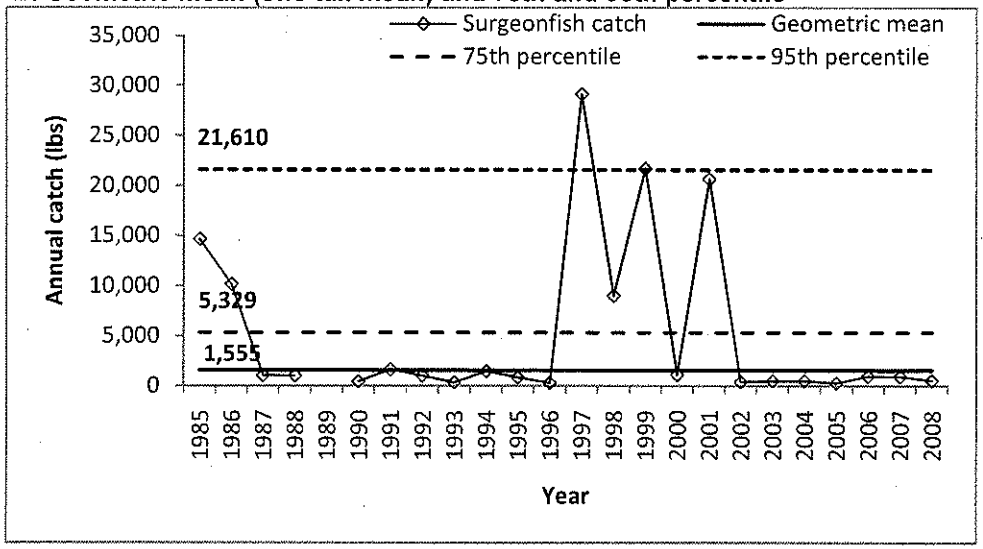
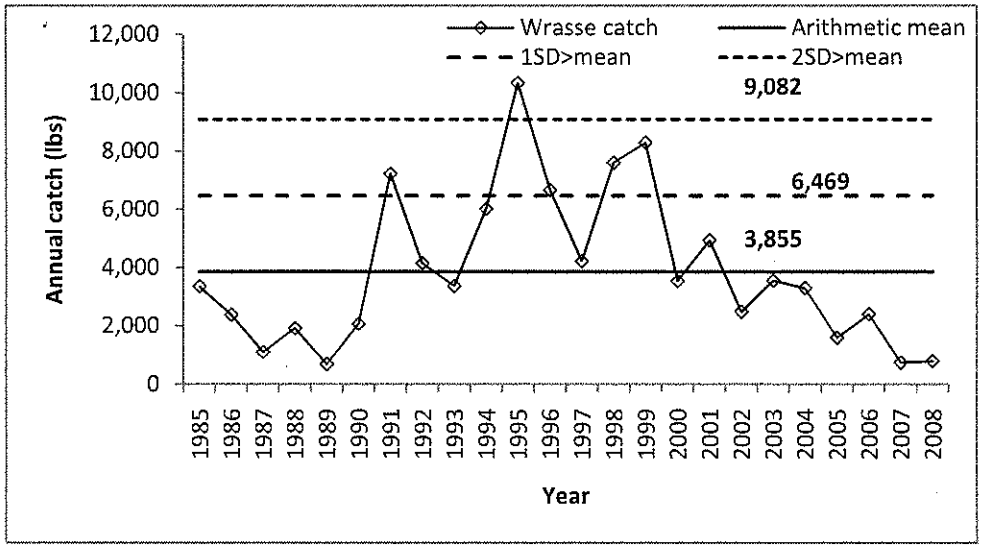


Figure 63. Temporal trend in annual catch of Labridae (wrasses except Cheilinus undulatus) in Guam showing 2 types of central tendencies and variations

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

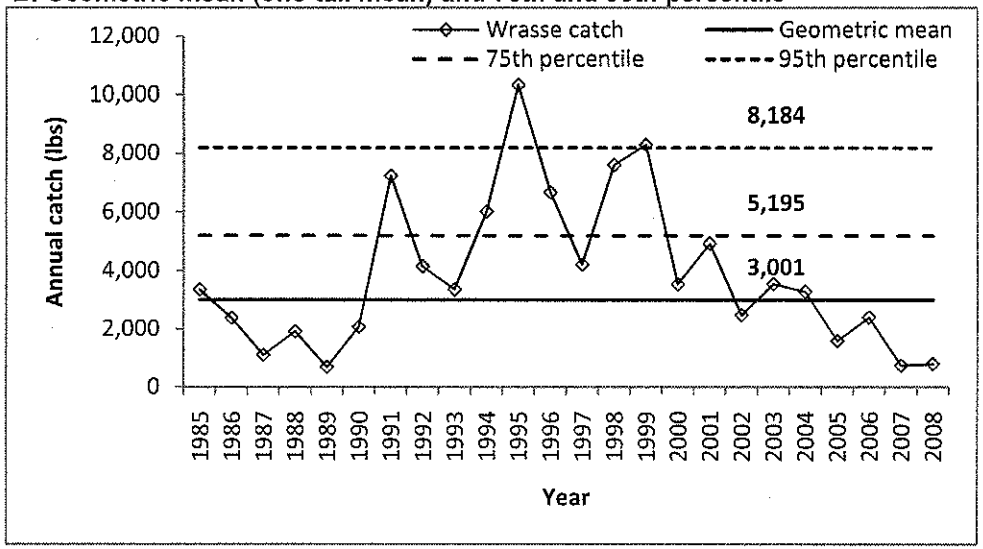
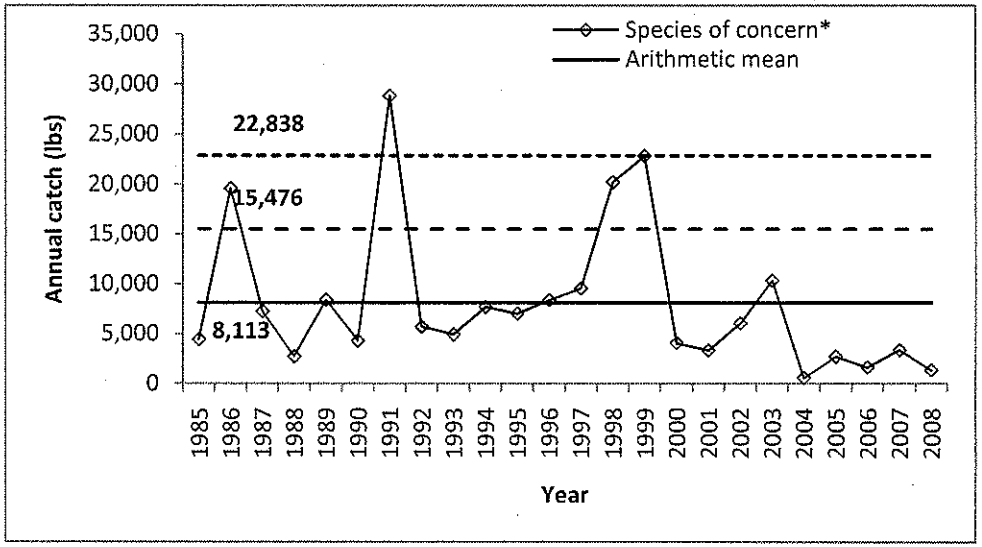


Figure 64. Temporal trend in annual catch of species of concern (C. undulatus, B. muricatum, reef sharks) in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

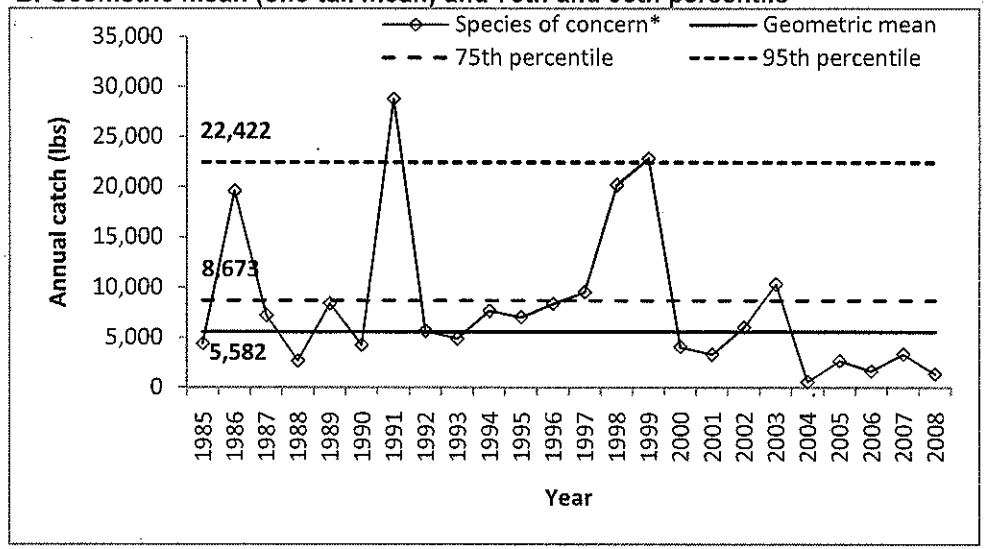
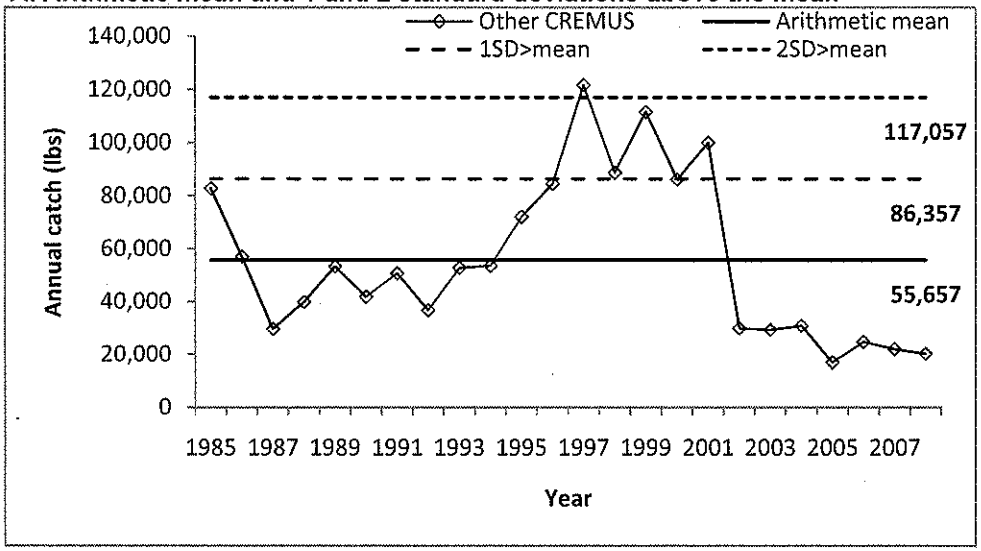
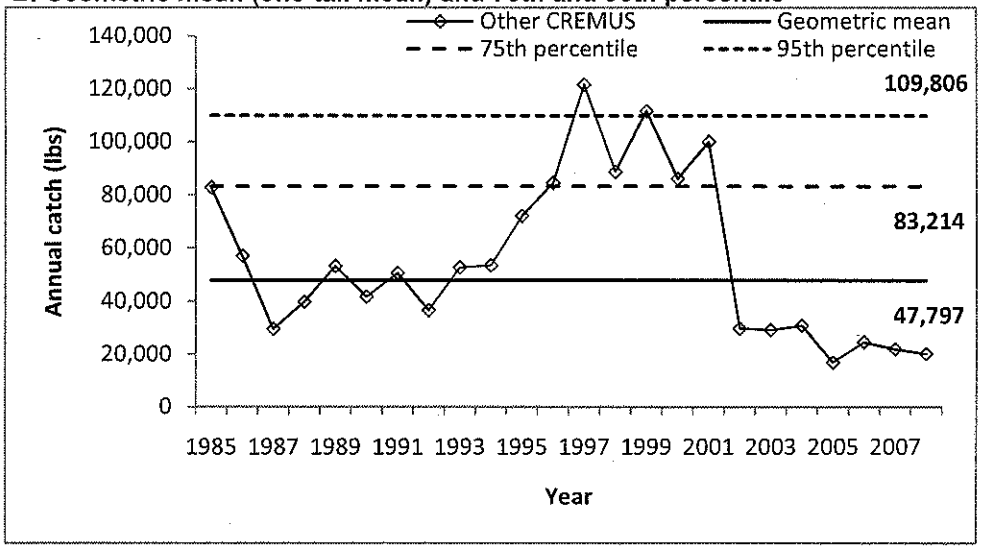


Figure 65. Temporal trend in annual catch of other CREMUS species assemblage making up the remaining 15% of the CREMUS catch in Guam showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile



LIST OF ALTERNATIVES FOR ACL SPECIFICATION IN THE CORAL REEF FISHERY IN HAWAII

Alternative 1.A. No Action

Alternative 1.B.: All CREMUS groupings aggregated

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
ALL CREMUS	204,364	43,288	247,652	290,940	199,848	239,505	271,057

Alternative 1.C.: Top 90% of CREMUS landing and rest of 10% binned together

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Jacks	49,150	23,490	72,640	96,131	43,579	67,205	94,221
Surgeonfish	31,026	7,610	38,635	46,245	30,105	36,884	43,059
Goatfish	29,885	13,863	43,749	57,612	25,062	36,360	53,942
Snappers	22,139	10,453	32,592	43,045	16,827	28,928	35,712
Squirrelfish	15,868	5,820	21,688	27,508	14,609	19,802	24,662
Parrotfish	11,667	6,425	18,092	24,517	9,217	16,260	20,698
Bonefish	6,885	4,836	11,721	16,557	5,228	9,835	16,351
Reef sharks	6,323	9,922	16,245	26,166	1,831	8,233	22,806
Barracuda	6,193	5,437	11,630	17,067	5,005	7,315	11,281
Rudderfish	5,740	2,842	8,582	11,423	5,071	7,066	10,171
Mullets	5,264	2,828	8,093	10,921	4,585	6,705	10,693
Other CREMUS	16,237	4,108	20,345	24,453	15,727	18,298	23,031

Alternative 1.D.: Individual CREMUS groupings

Family	Arithmetic mean + SD				Geometric mean & percentile		
	Mean	StDev	1SD>mean	2SD>mean	Geomean	75th_%ile	95th_%ile
Jacks	49,150	23,490	72,640	96,131	43,579	67,205	94,221
Surgeonfish	31,026	7,610	38,635	46,245	30,105	36,884	43,059
Goatfish	29,885	13,863	43,749	57,612	25,062	36,360	53,942
Snappers	22,139	10,453	32,592	43,045	16,827	28,928	35,712
Squirrelfish	15,868	5,820	21,688	27,508	14,609	19,802	24,662
Parrotfish	11,667	6,425	18,092	24,517	9,217	16,260	20,698
Bonefish	6,885	4,836	11,721	16,557	5,228	9,835	16,351
Reef sharks	6,323	9,922	16,245	26,166	1,831	8,233	22,806
Barracuda	6,193	5,437	11,630	17,067	5,005	7,315	11,281
Rudderfish	5,740	2,842	8,582	11,423	5,071	7,066	10,171
Mullets	5,264	2,828	8,093	10,921	4,585	6,705	10,693
Wrasse	3,532	1,256	4,787	6,043	3,309	4,191	5,922
Bigeye soldier	2,387	1,262	3,649	4,911	2,123	2,648	4,989
Flagtails	2,062	896	2,958	3,854	1,878	2,548	3,338
Threadfins	1,627	2,090	3,717	5,807	836	1,906	5,330
Lionfish	1,279	485	1,763	2,248	1,179	1,661	2,028
Moray eels	1,022	1,106	2,128	3,234	366	1,850	2,950
Emperors	910	747	1,657	2,405	611	1,209	2,066
Puffers	892	1,933	2,825	4,757	325	816	2,957
Damselfish	823	324	1,147	1,471	762	970	1,367
Triggerfish	403	369	772	1,141	222	610	1,105
Halfbeaks	323	617	940	1,557	138	211	2,060
Conger eels	295	272	567	839	165	483	752
Grouper roi only	390	300	691	991	313	470	919
Hawkfish	302	156	458	614	252	400	575
Trumpetfish	49	40	90	130	36	60	132

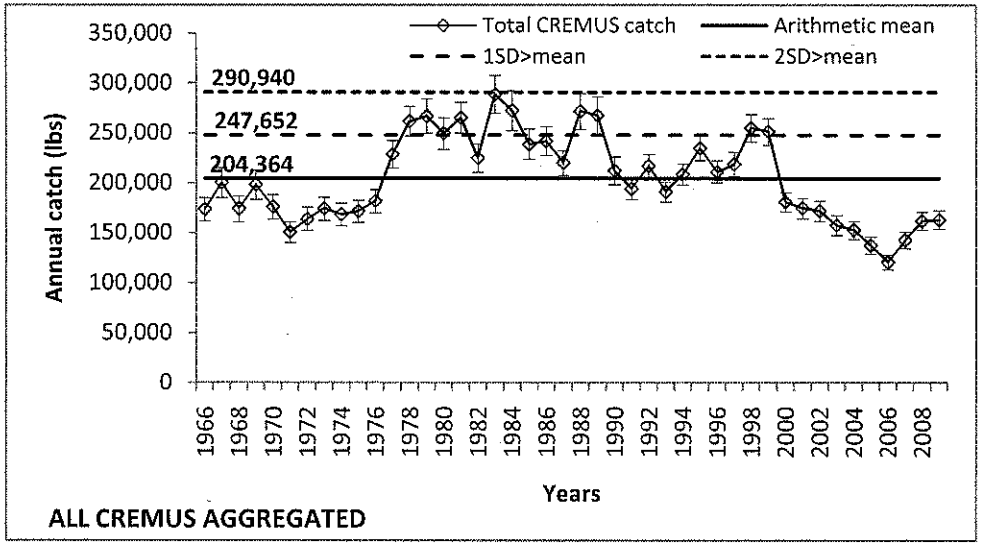
Butterflyfish	83	85	168	253	44	79	237
Apogons	47	67	114	182	19	48	221
Eagle ray	70	112	182	294	21	75	311
Boxfish	41	134	176	310	9	25	70
Solefish	15	14	28	42	10	18	36

NOTE:

* excludes Bolbometopon muricatum (bumphead parrotfish)
** excludes Cheilinus undulatus (humphead wrasse)
*** includes reef sharks, C. undulatus, B. muricatum
**** includes uni'd fish and other sp. & comprise the remaining 15% of the CREMUS catch

Figure 66. Temporal trend in annual catch of all species listed under CREMUS in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

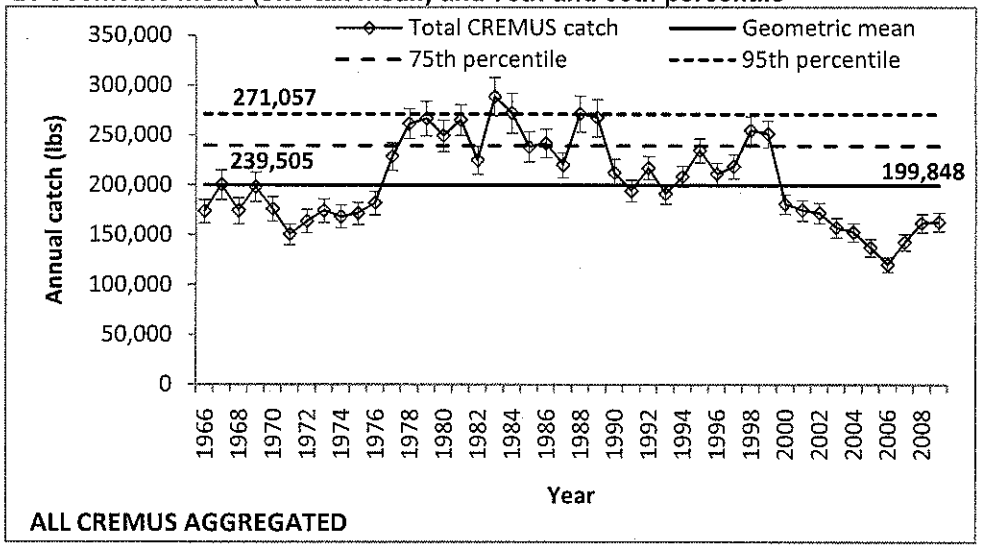
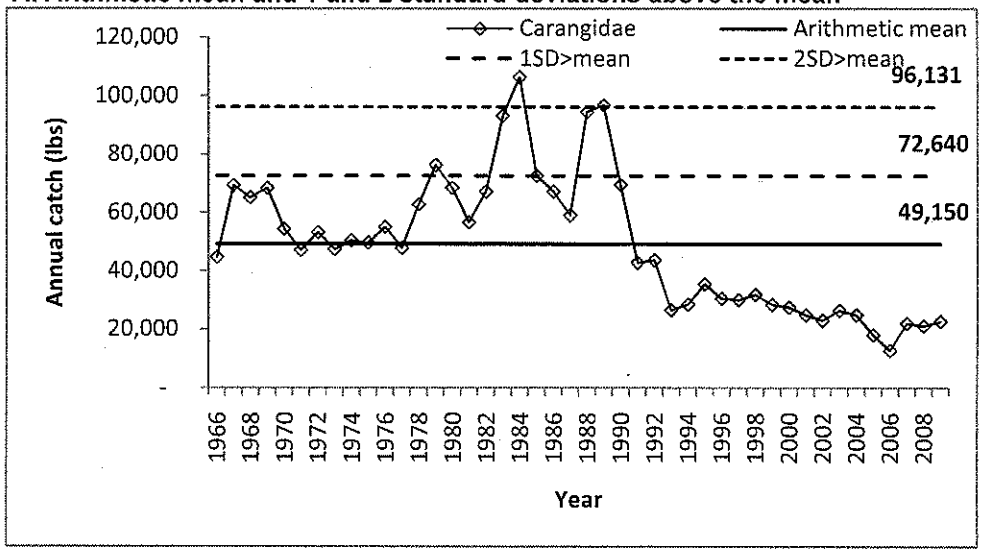


Figure 67. Temporal trend in annual catch of Carangidae (jacks) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

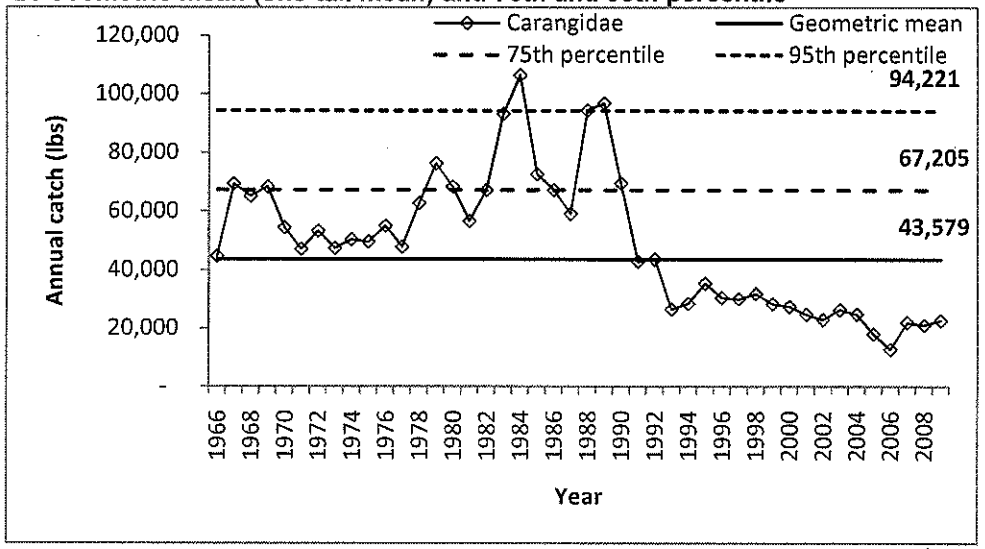
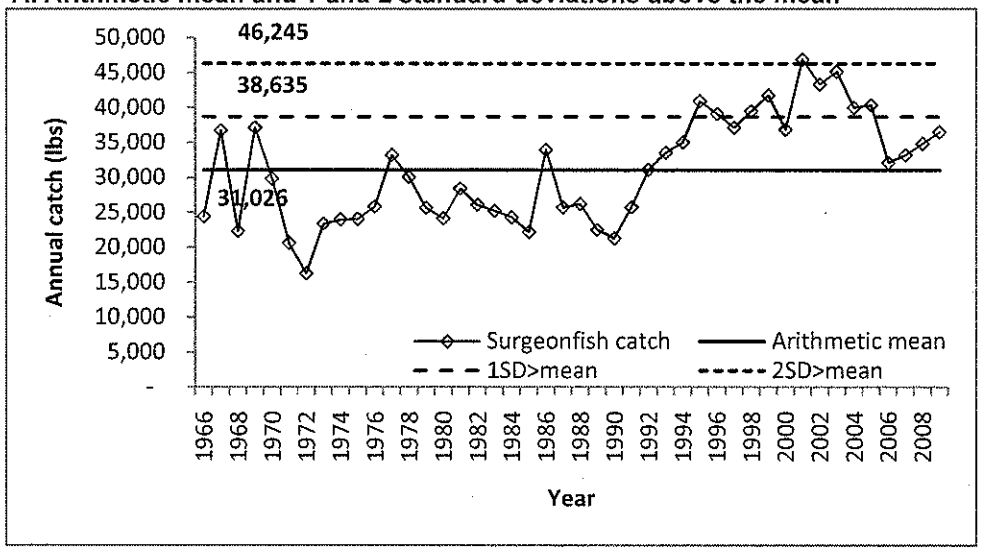


Figure 68. Temporal trend in annual catch of Acanthuridae (surgeonfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

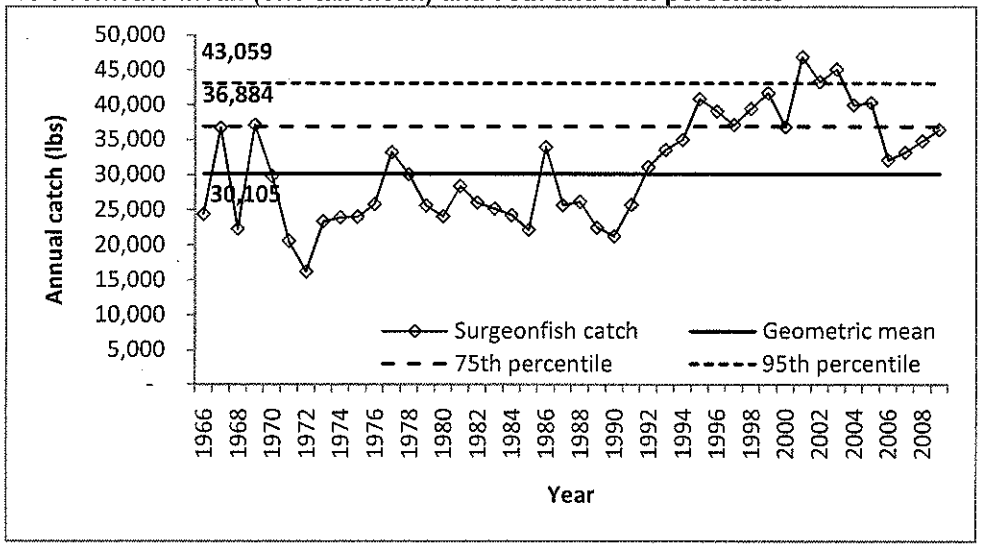
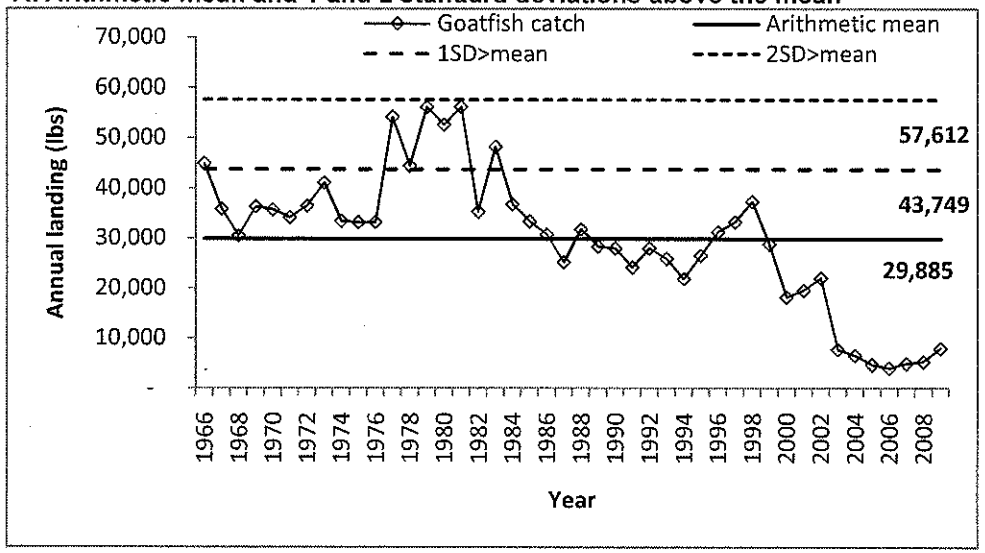


Figure 69. Temporal trend in annual catch of Mullidae (goatfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

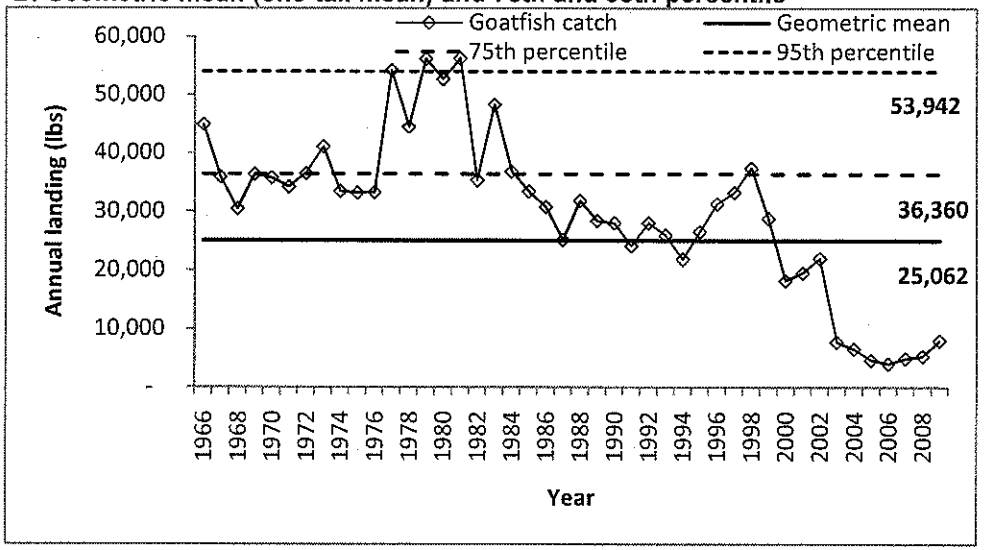
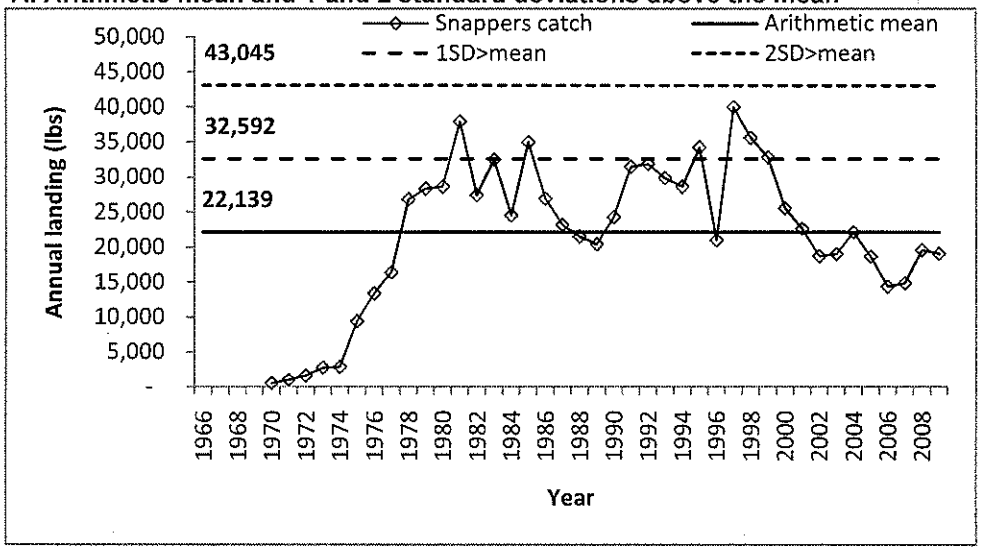


Figure 70. Temporal trend in annual catch of Lutjanidae (snappers) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

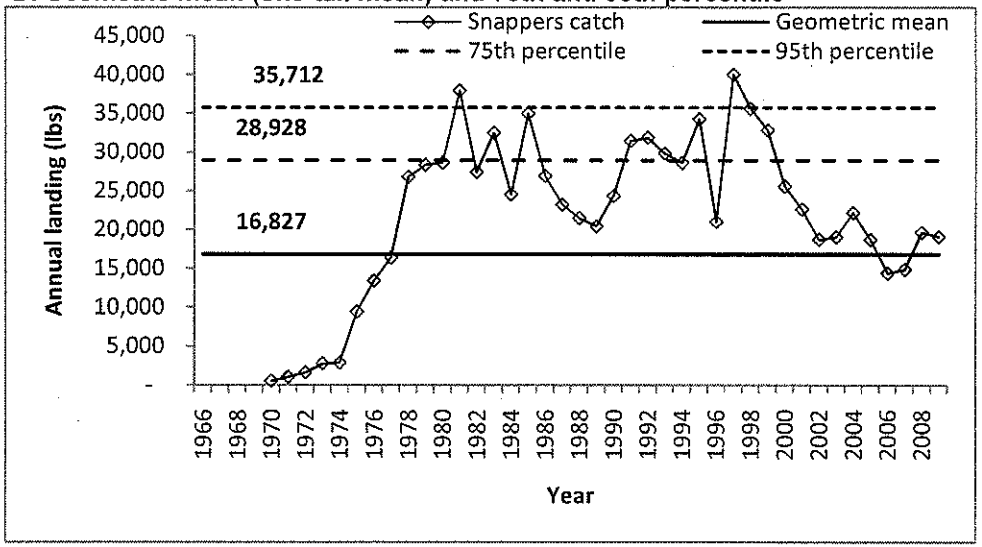
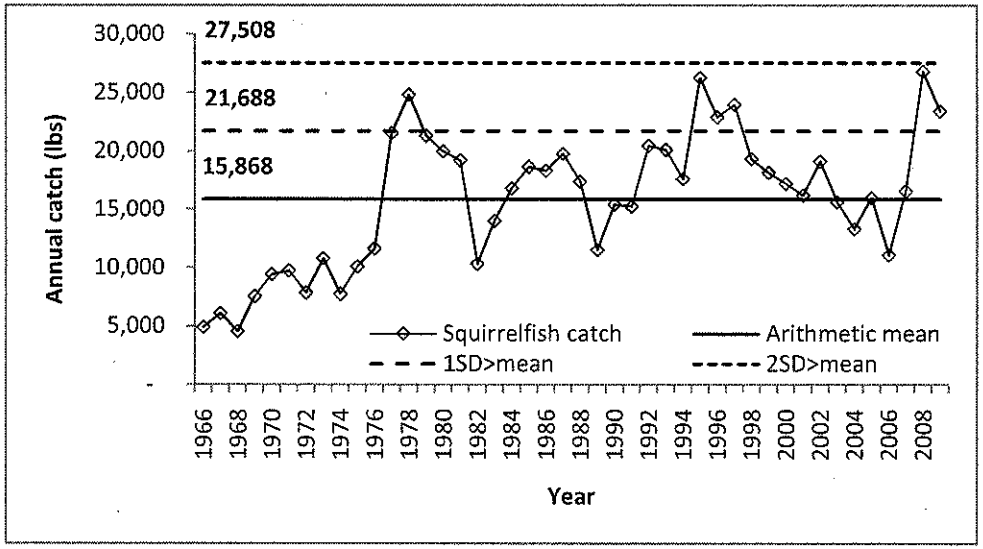


Figure 71. Temporal trend in annual catch of Holocentridae (squirrelfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

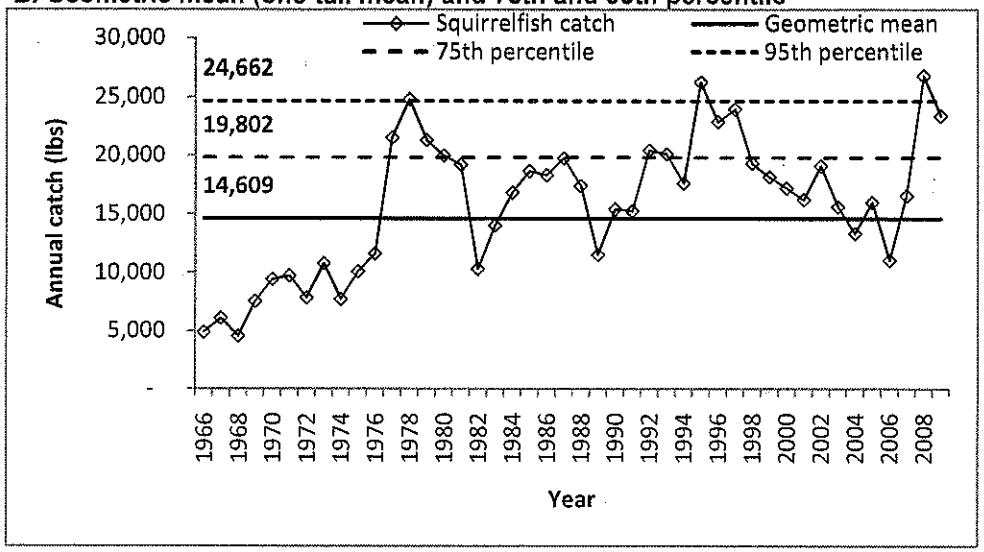
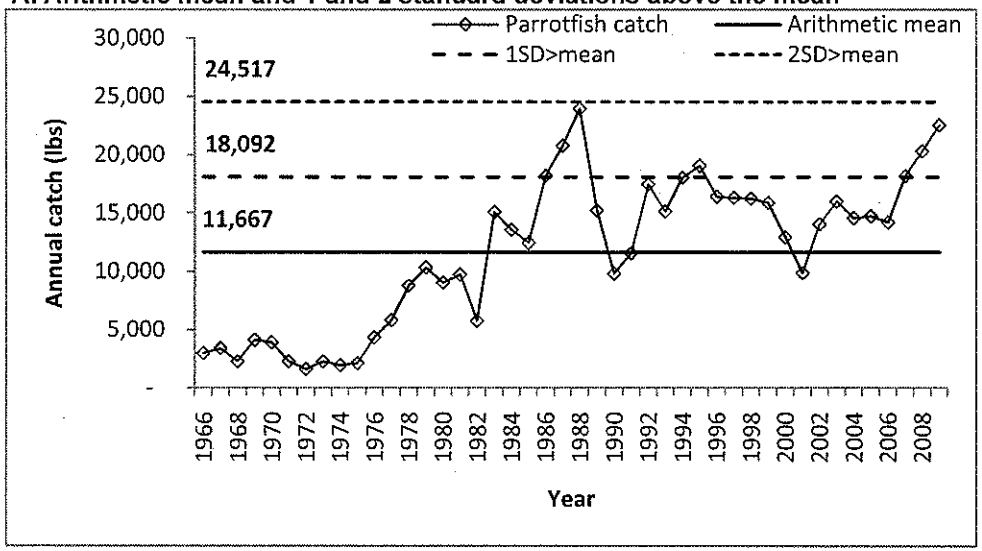


Figure 72. Temporal trend in annual catch of Scaridae (parrotfish except Bolbometopon muricatum) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

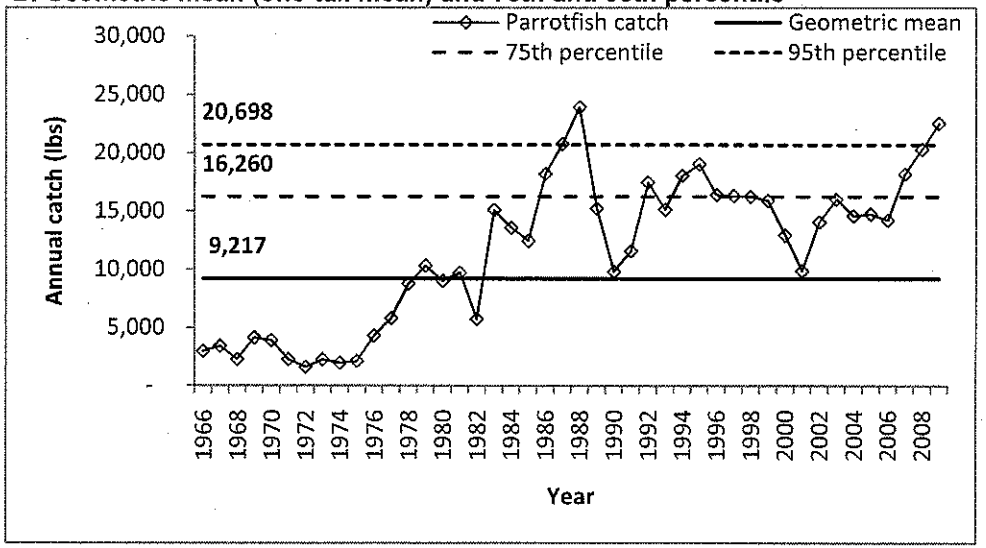
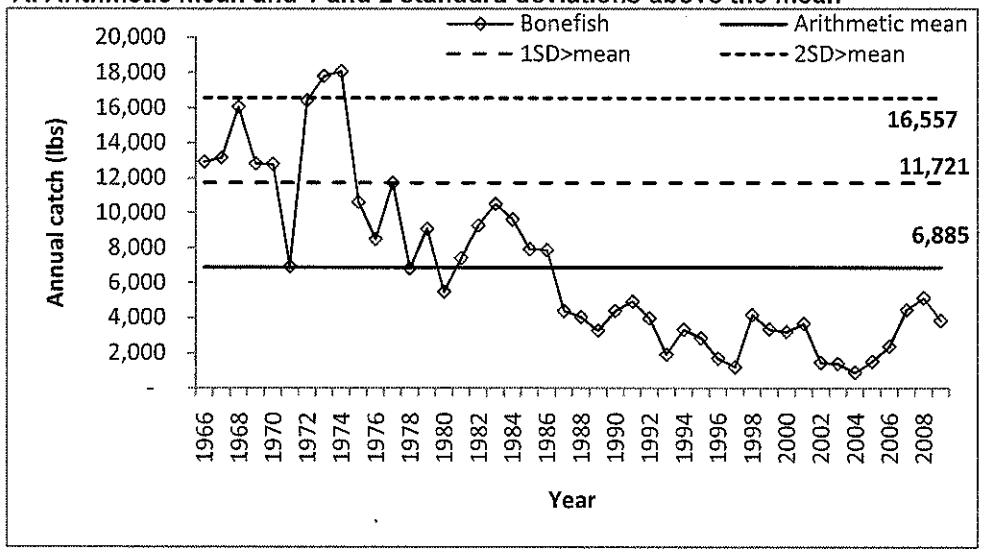


Figure 73. Temporal trend in annual catch of bonefish in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

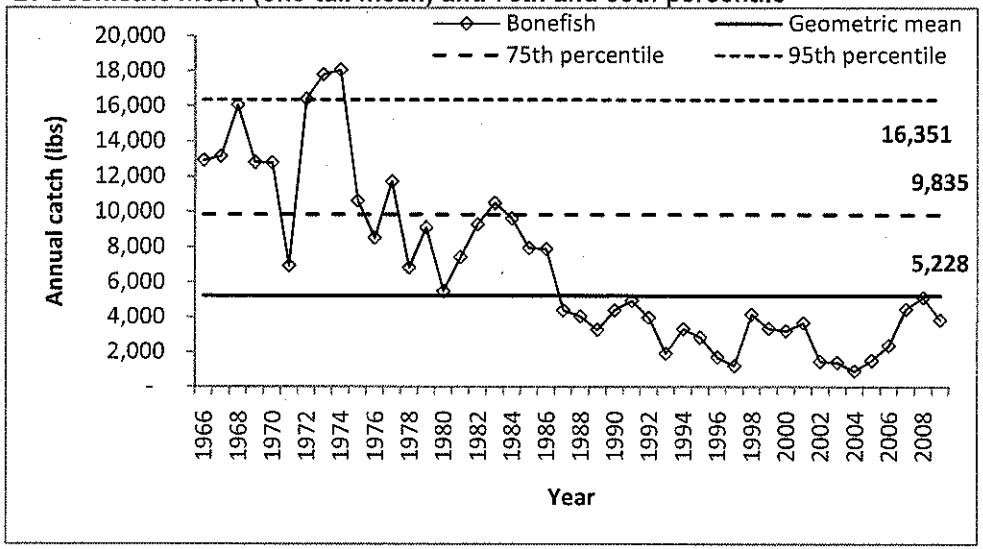
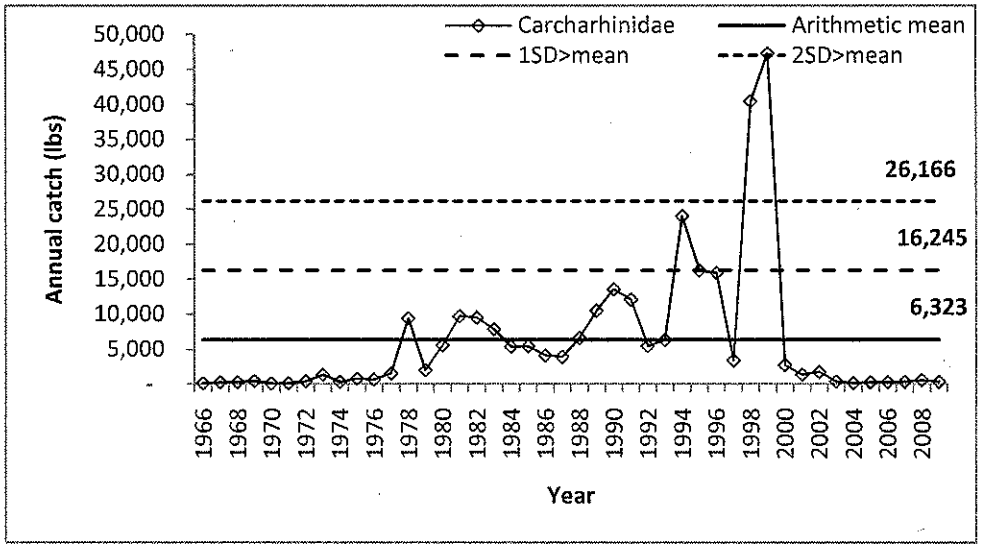


Figure 74. Temporal trend in annual catch of Carcharhinidae (sharks) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

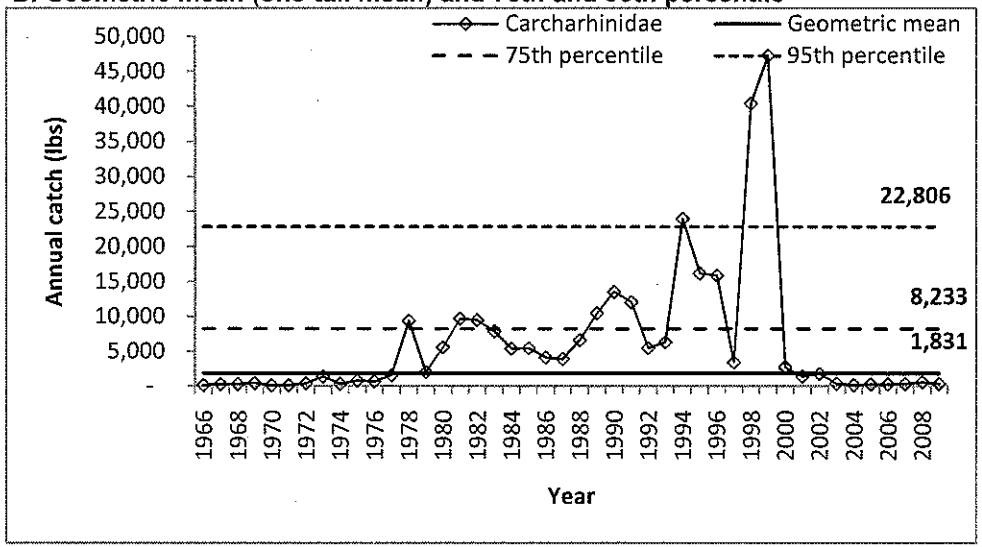
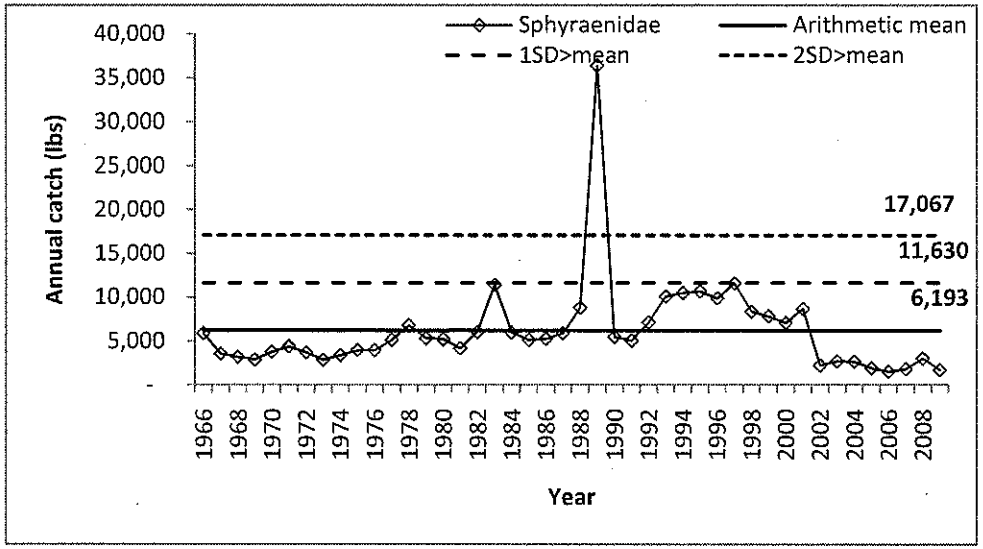


Figure 75. Temporal trend in annual catch of Sphyraenidae (barracuda) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

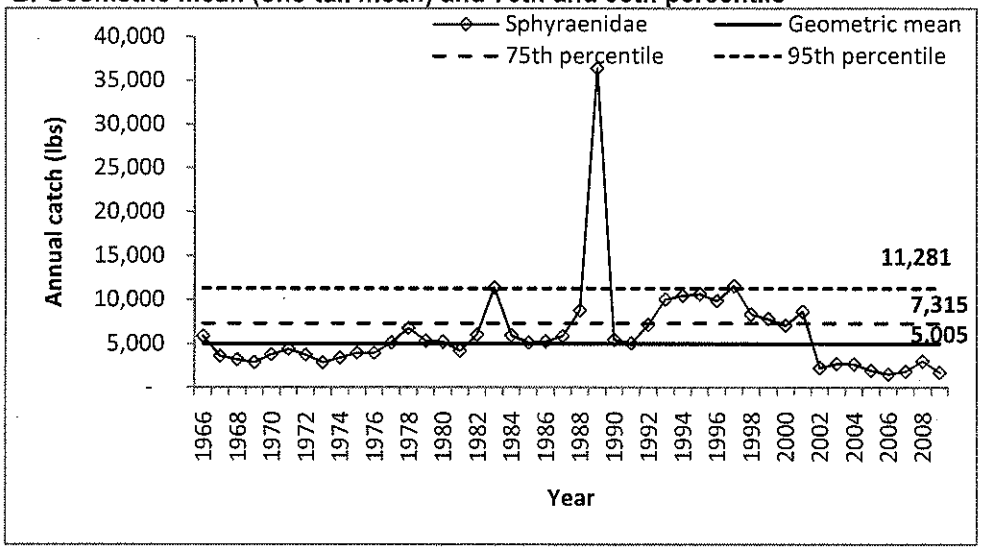
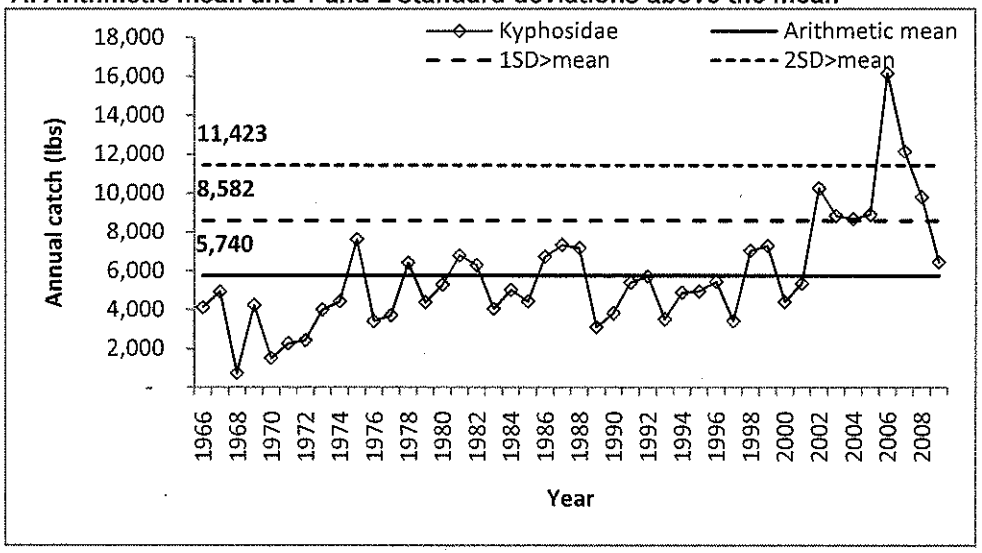


Figure 76. Temporal trend in annual catch of Kyphosidae (rudderfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

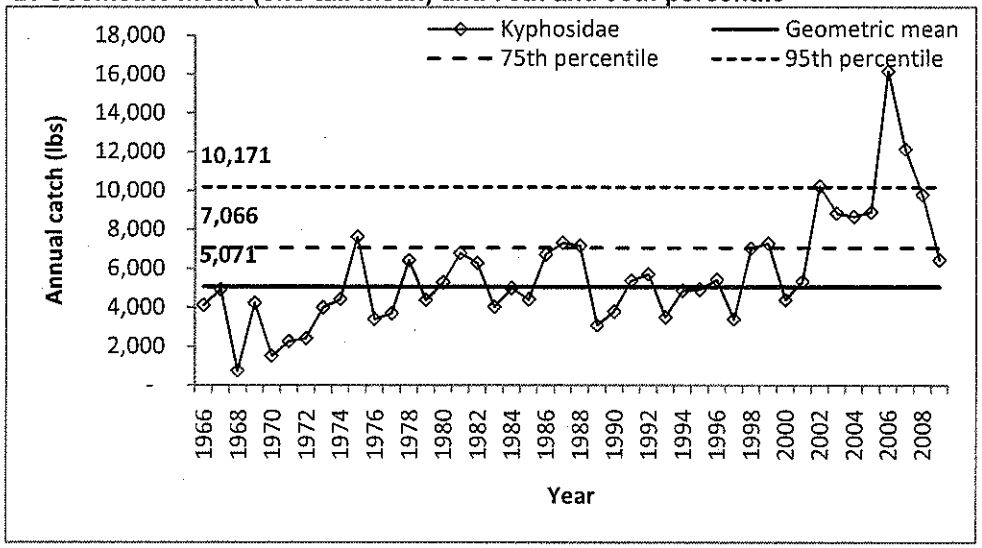
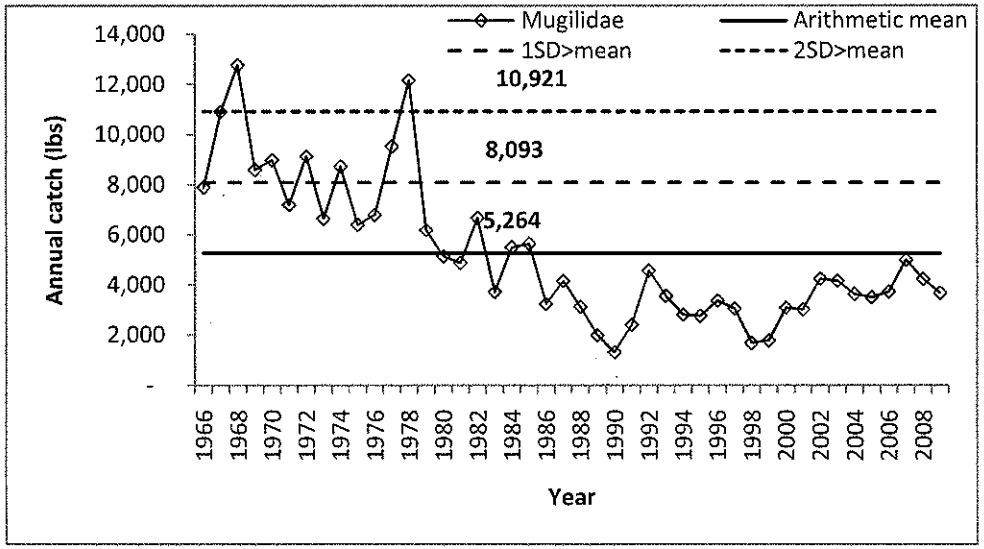


Figure 77. Temporal trend in annual catch of Mugilidae (mullets) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

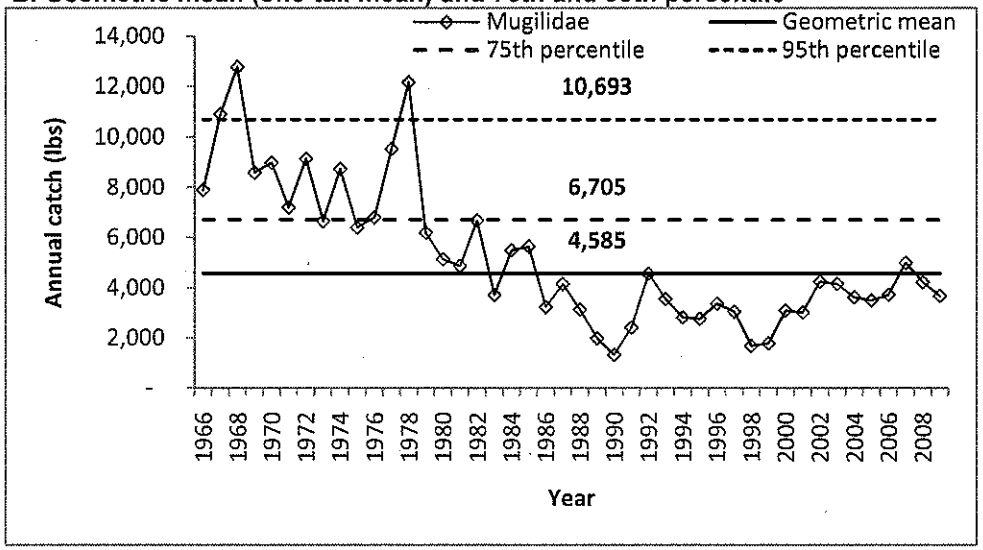
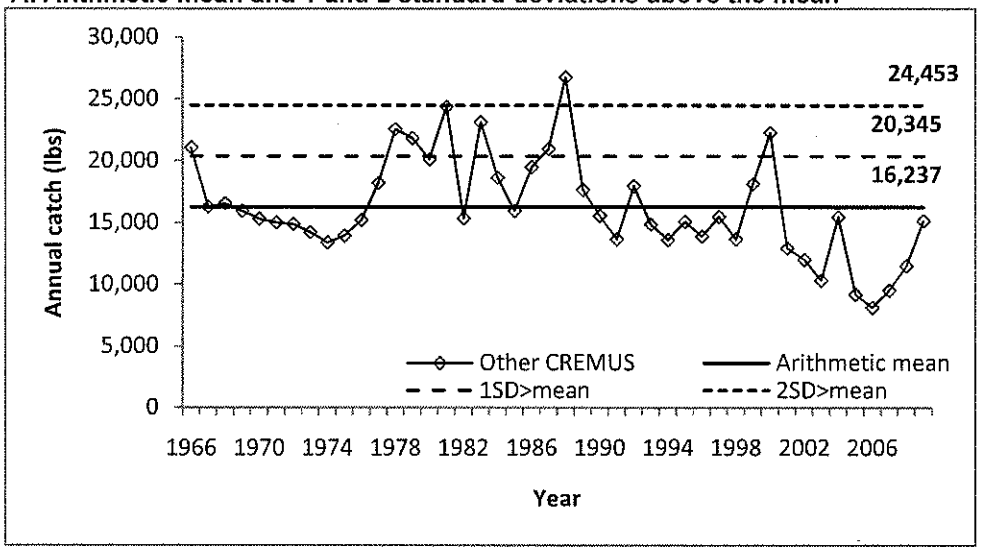


Figure 78. Temporal trend in annual catch of other CREMUS species assemblage making up the remaining 15% of the CREMUS catch in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

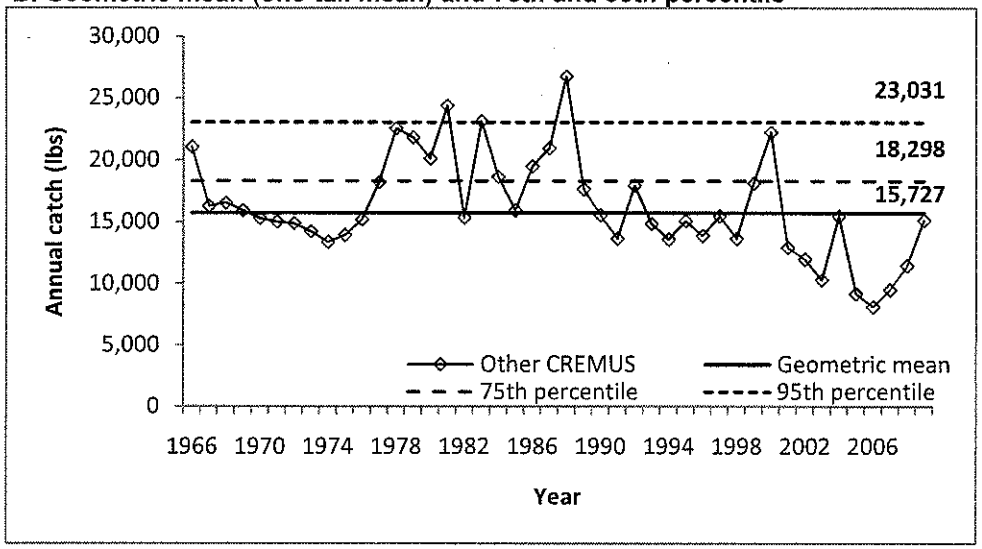
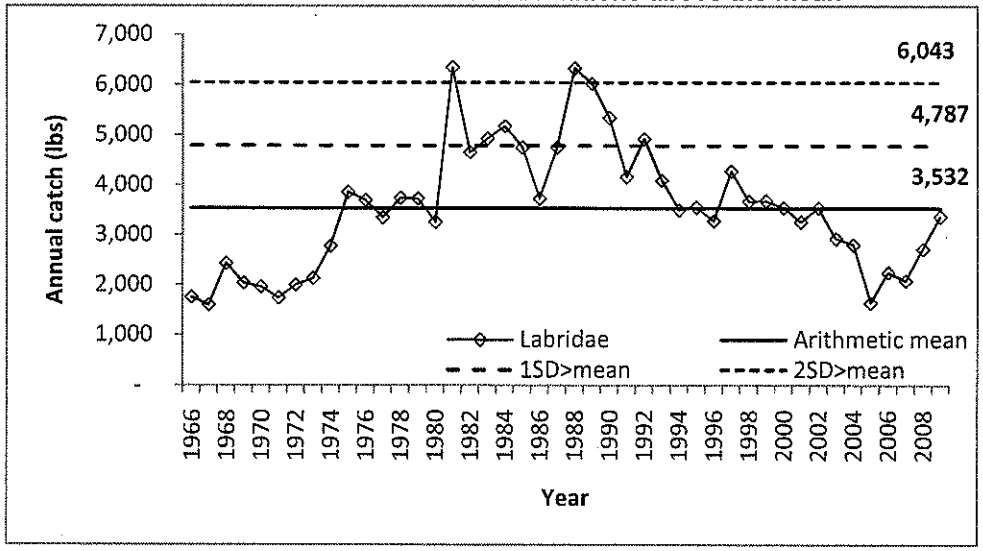


Figure 79. Temporal trend in annual catch of Labridae (wrasses) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

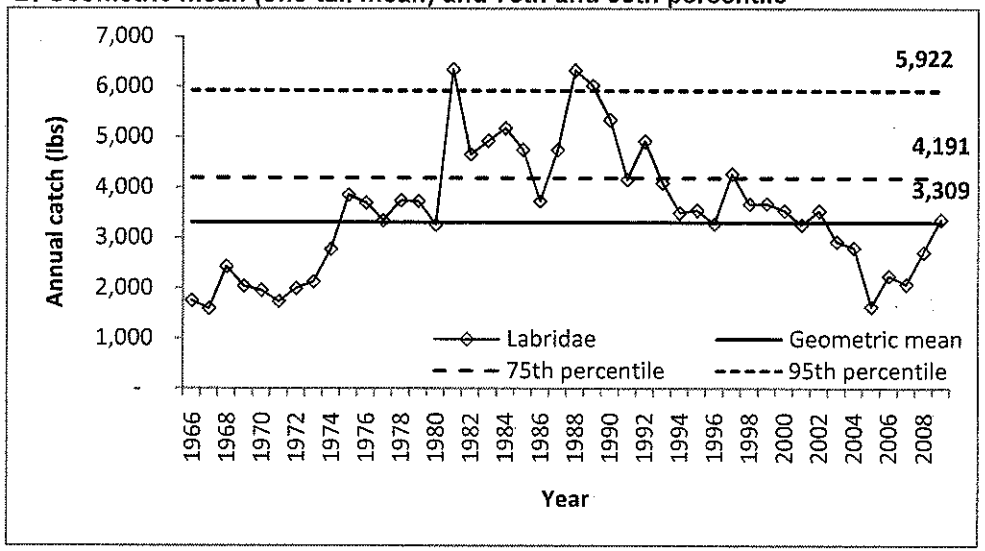
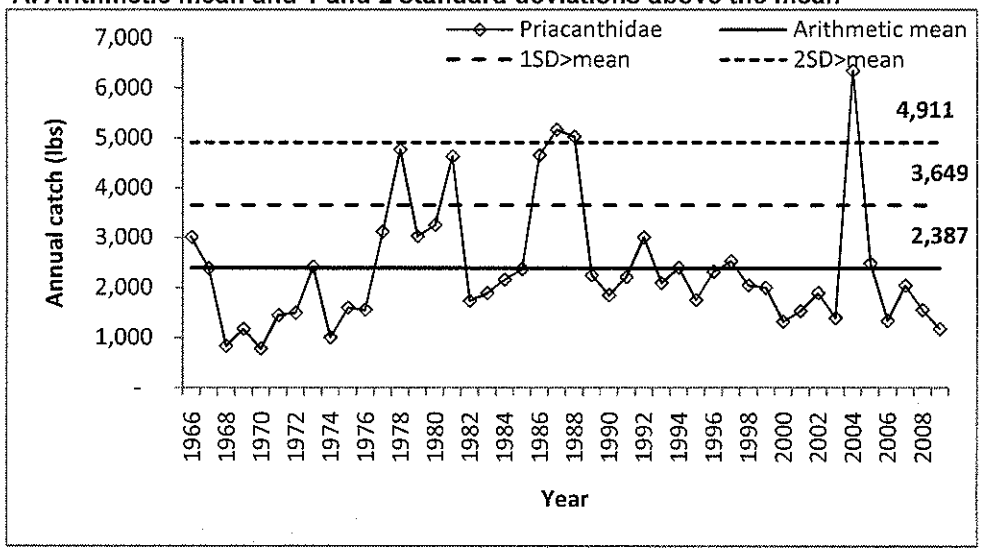


Figure 80. Temporal trend in annual catch of Priacanthidae in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

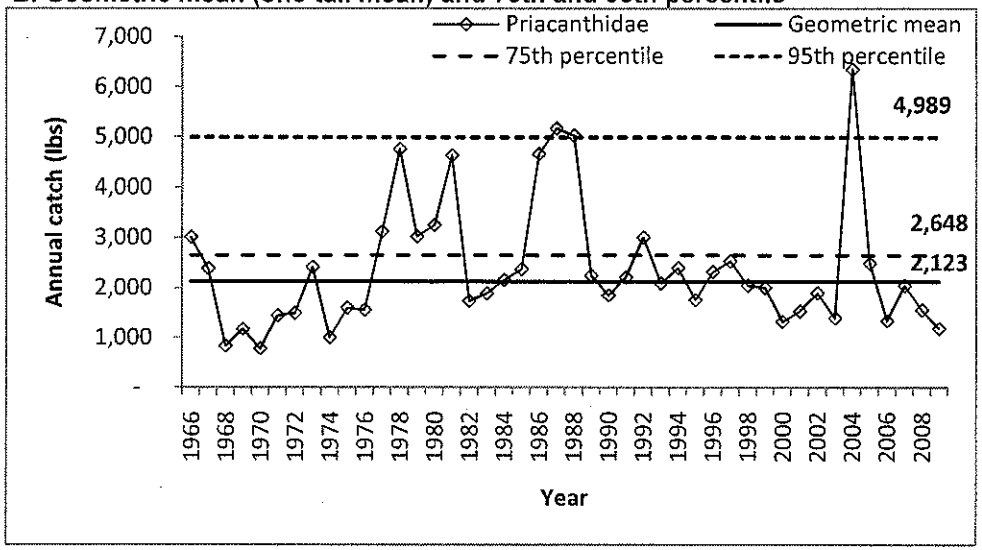
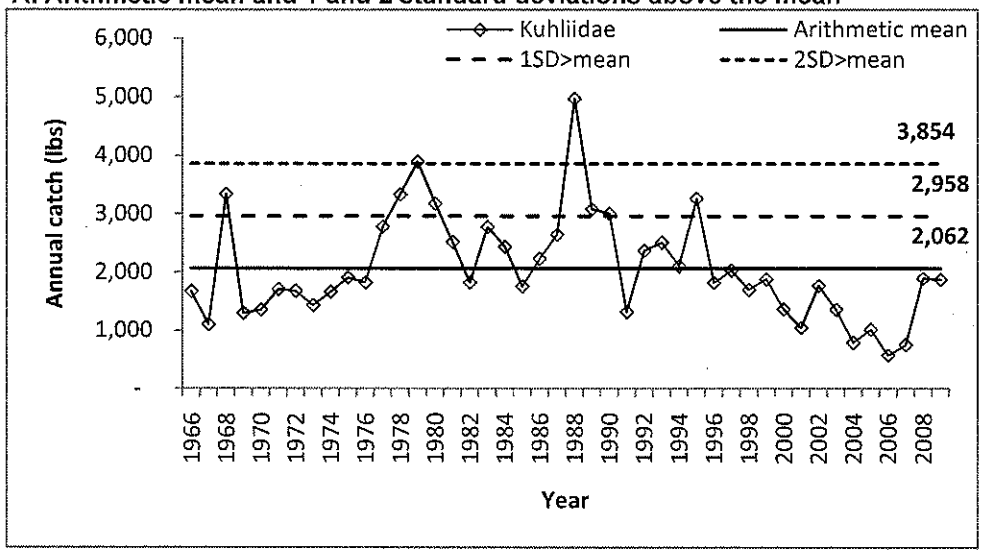


Figure 81. Temporal trend in annual catch of Kuhliidae in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

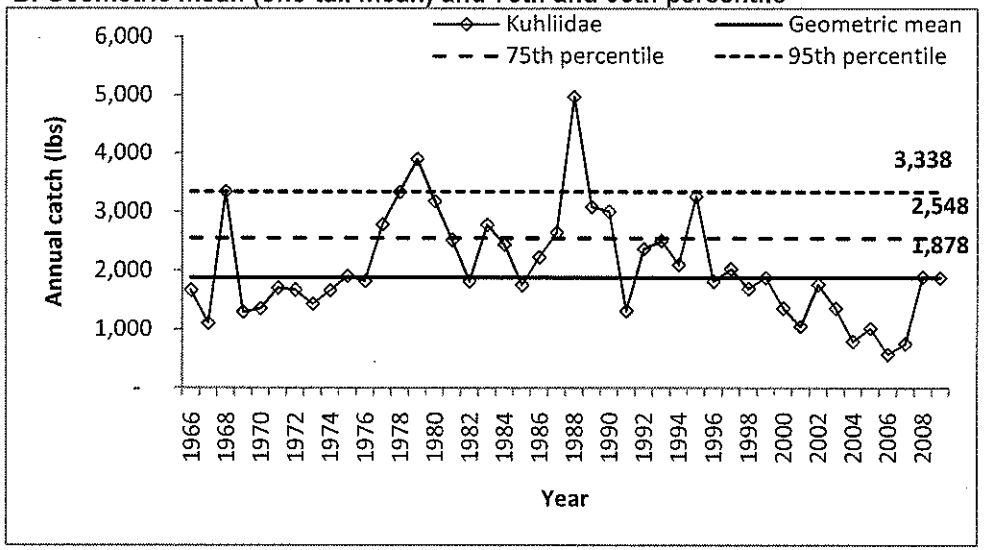
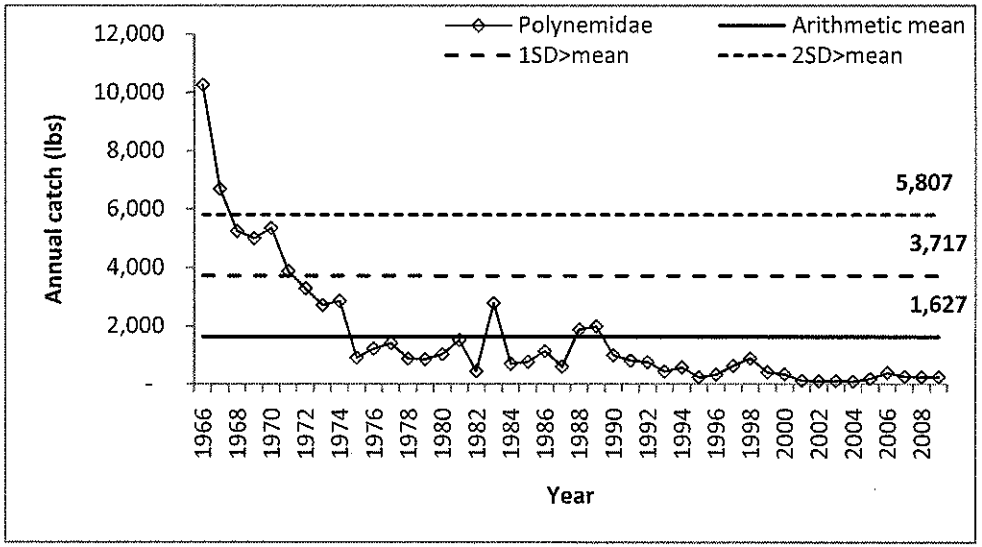


Figure 82. Temporal trend in annual catch of Polynemidae in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

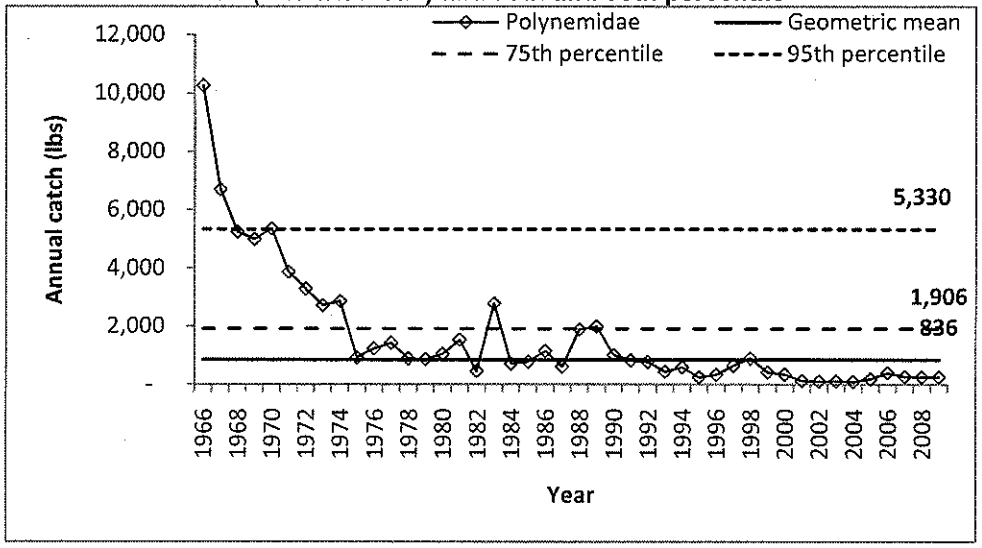
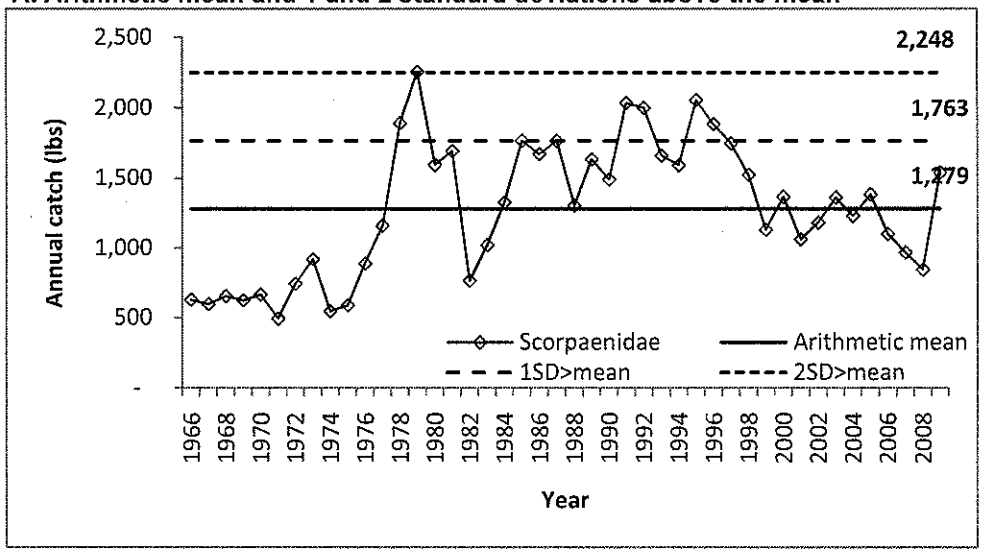


Figure 83. Temporal trend in annual catch of Scorpaenidae (lionfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

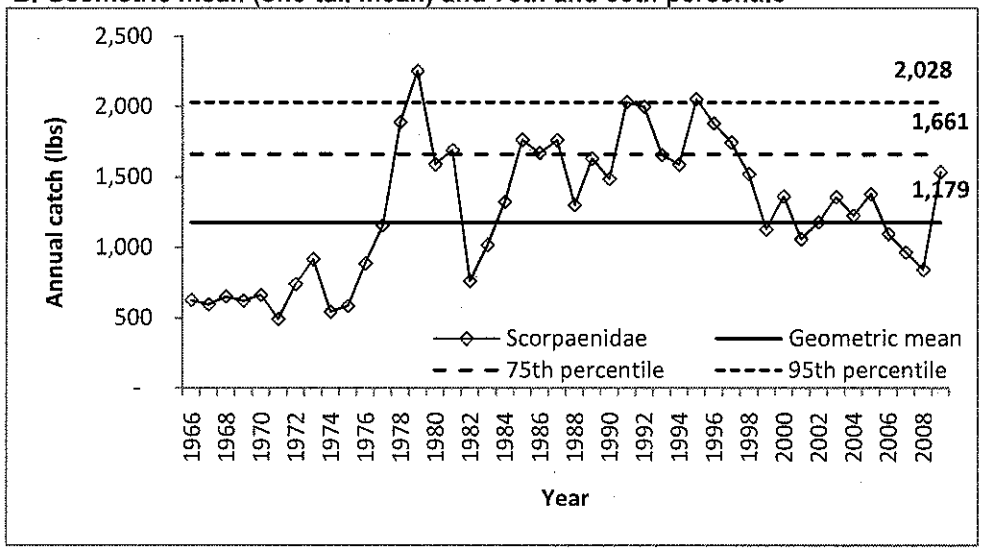
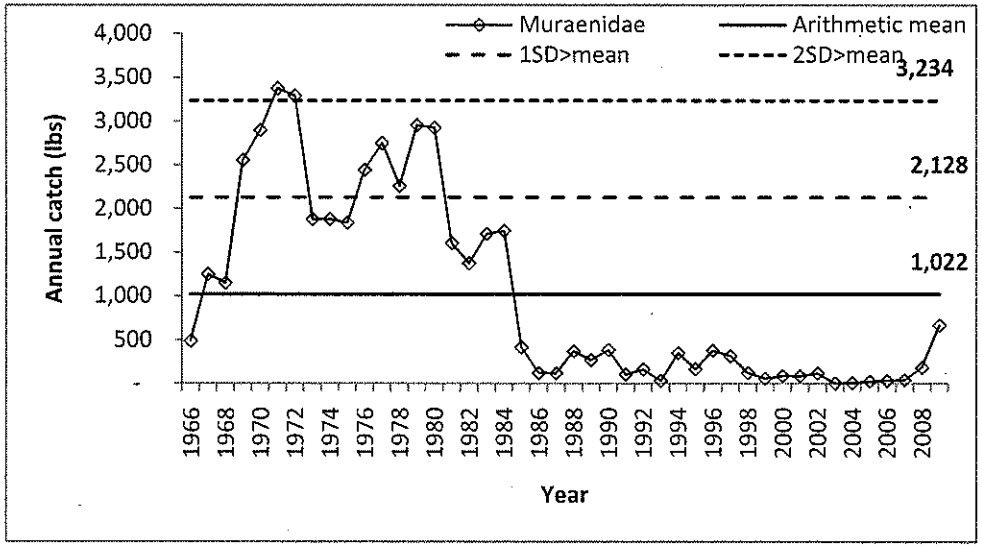


Figure 84. Temporal trend in annual catch of Muraenidae (morays) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

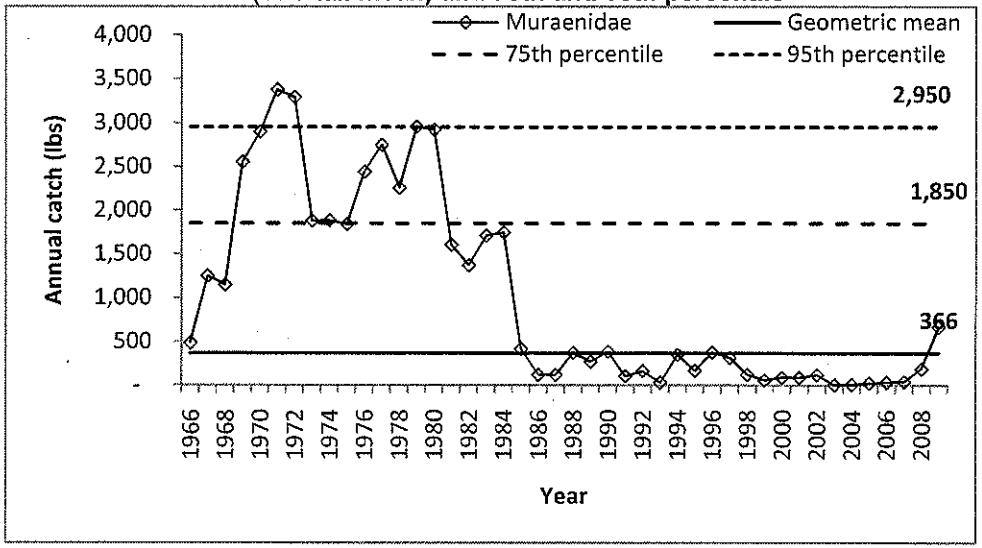
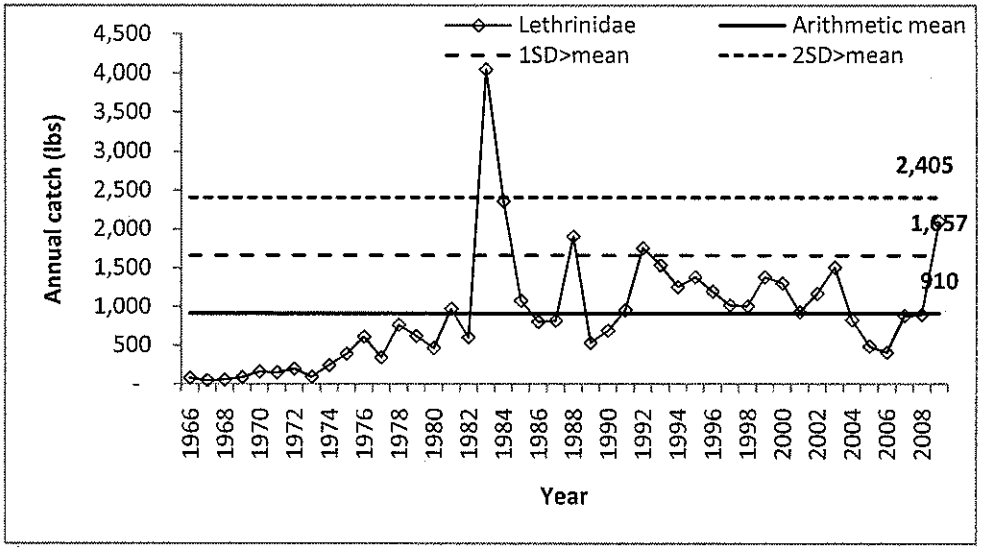


Figure 85. Temporal trend in annual catch of Lethrinidae (emperors) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

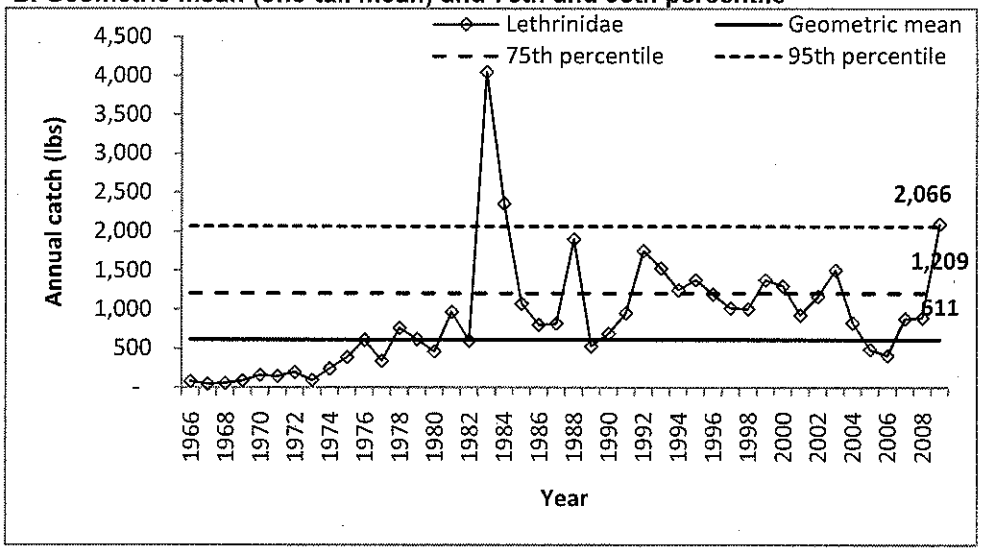
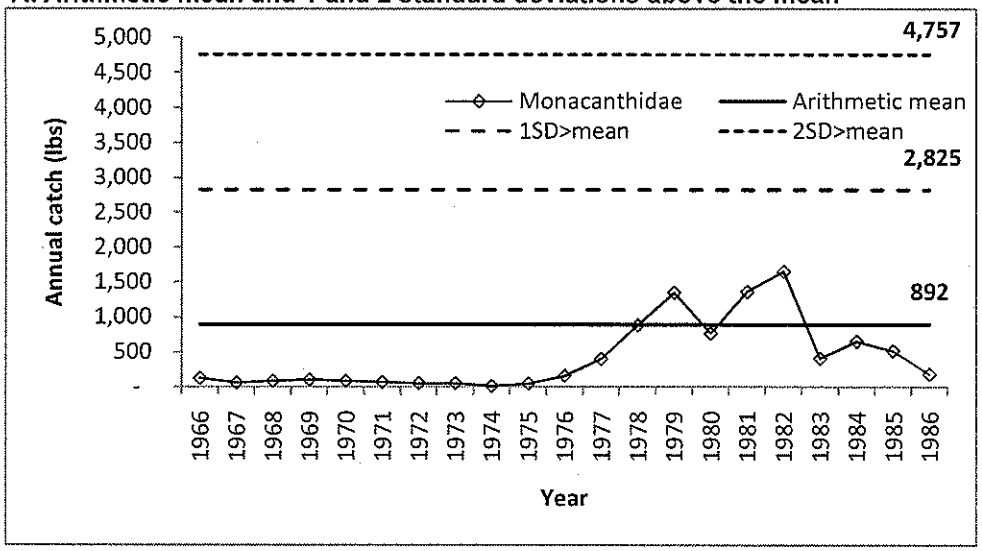


Figure 86. Temporal trend in annual catch of Monacanthidae in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

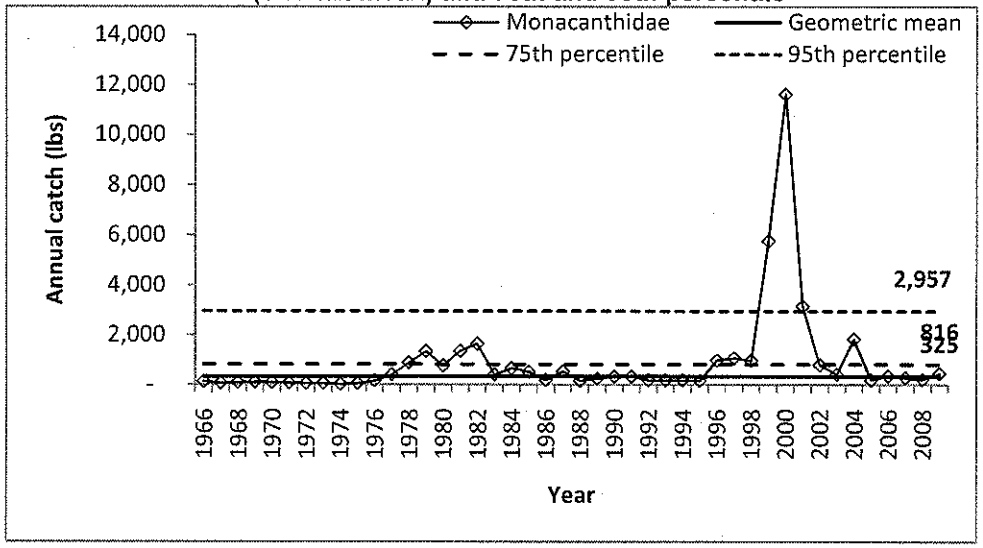
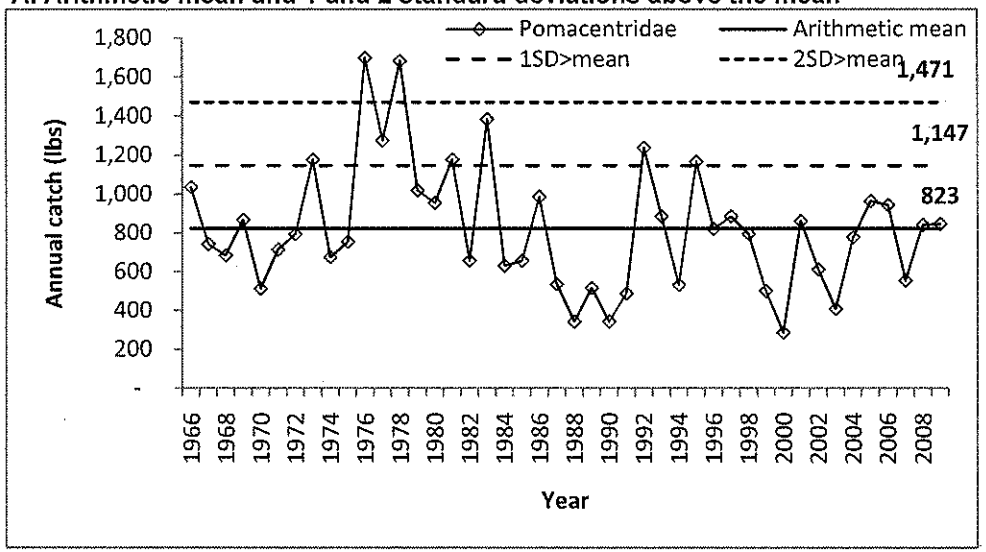


Figure 87. Temporal trend in annual catch of Pomacentridae (damsels) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

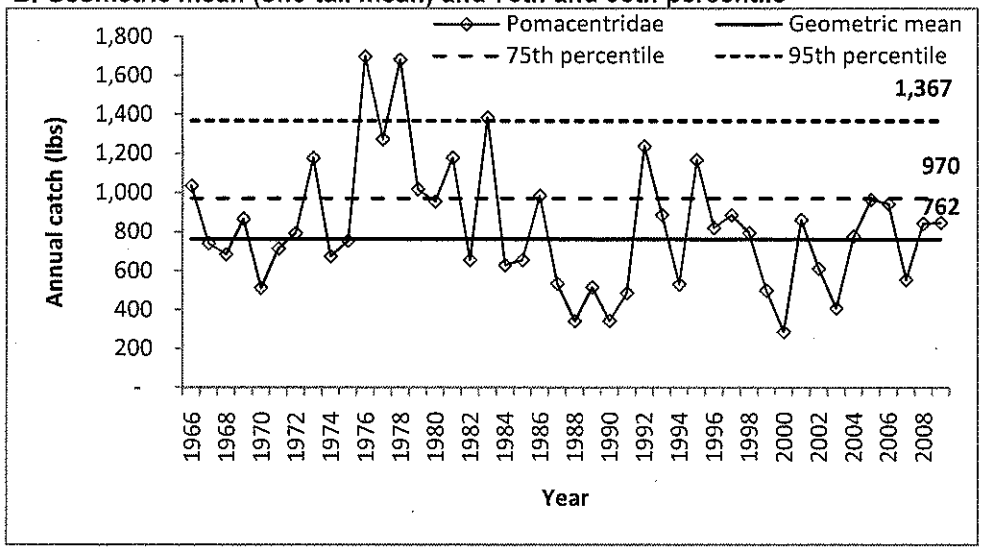
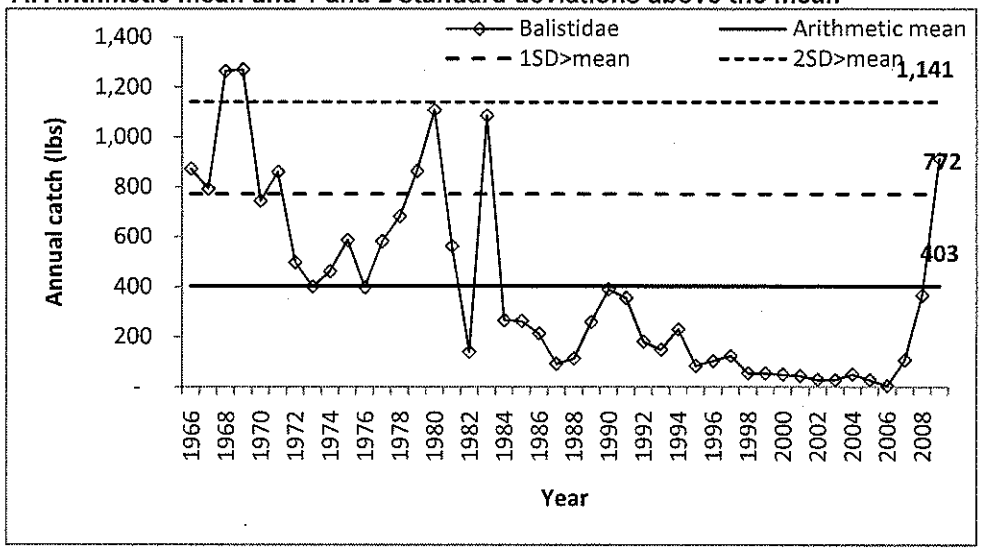


Figure 88. Temporal trend in annual catch of Balistidae (triggerfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

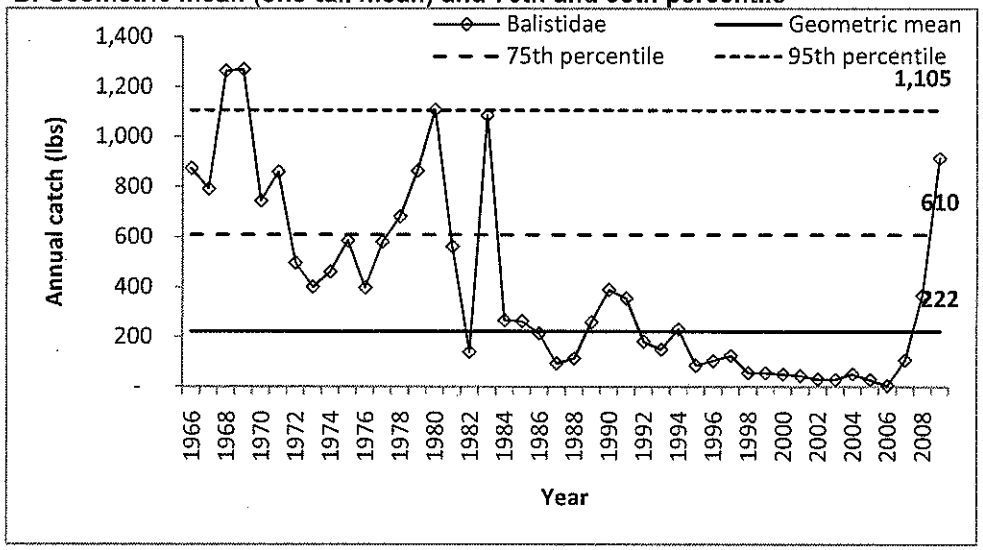
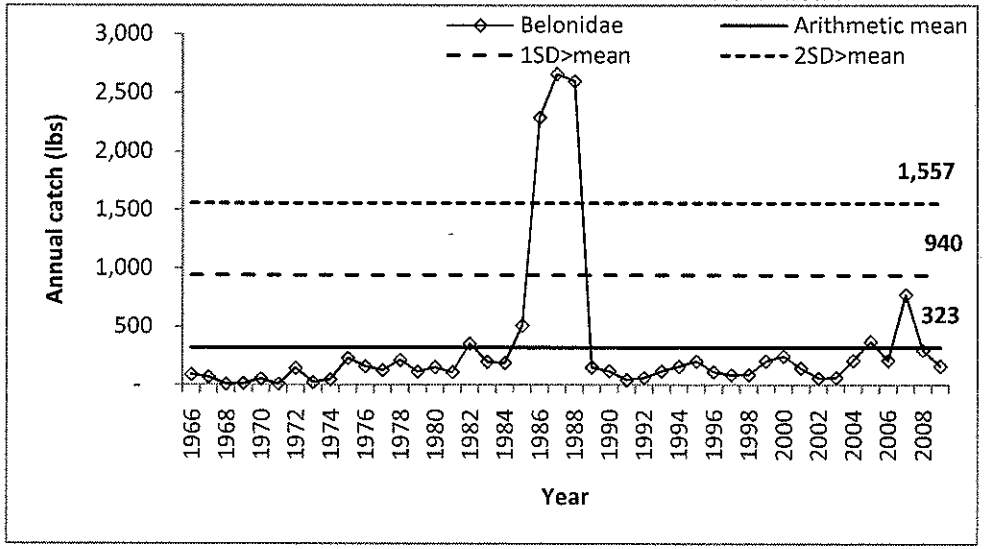


Figure 89. Temporal trend in annual catch of Belonidae (needlefish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

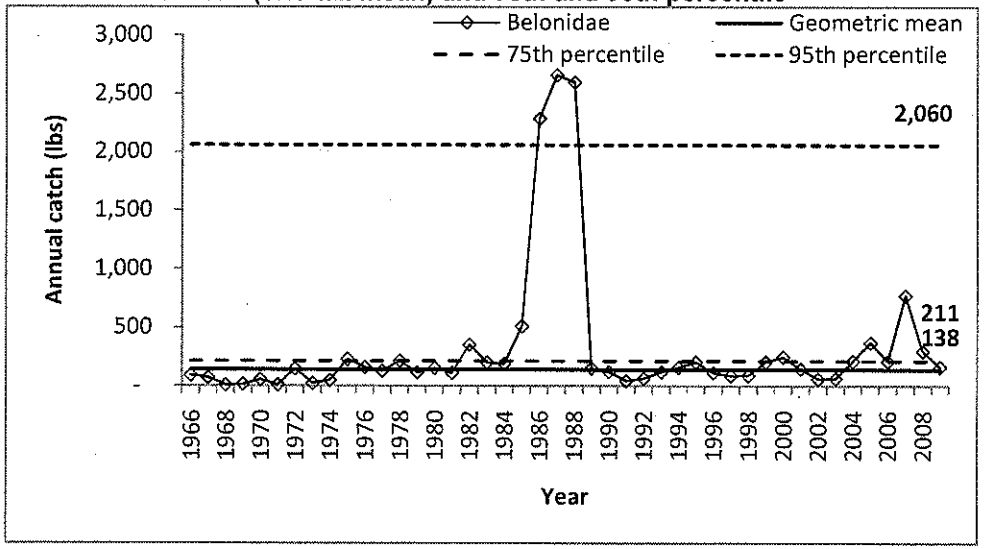
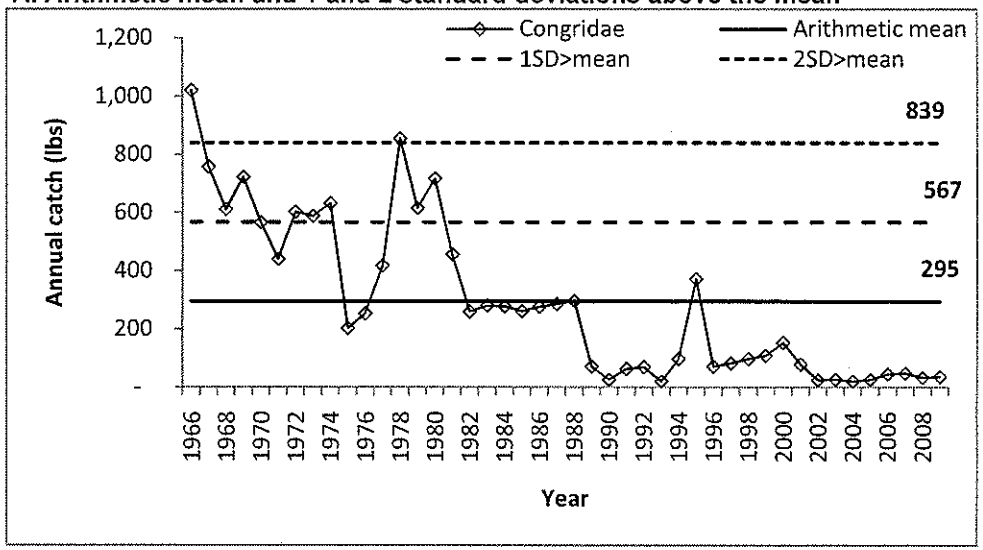


Figure 90. Temporal trend in annual catch of Congridae (conger eels) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

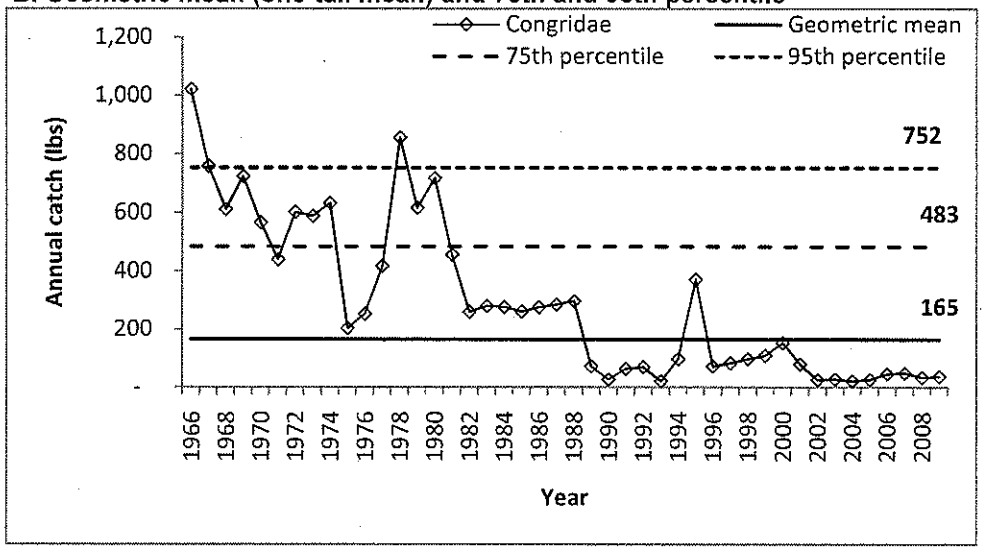
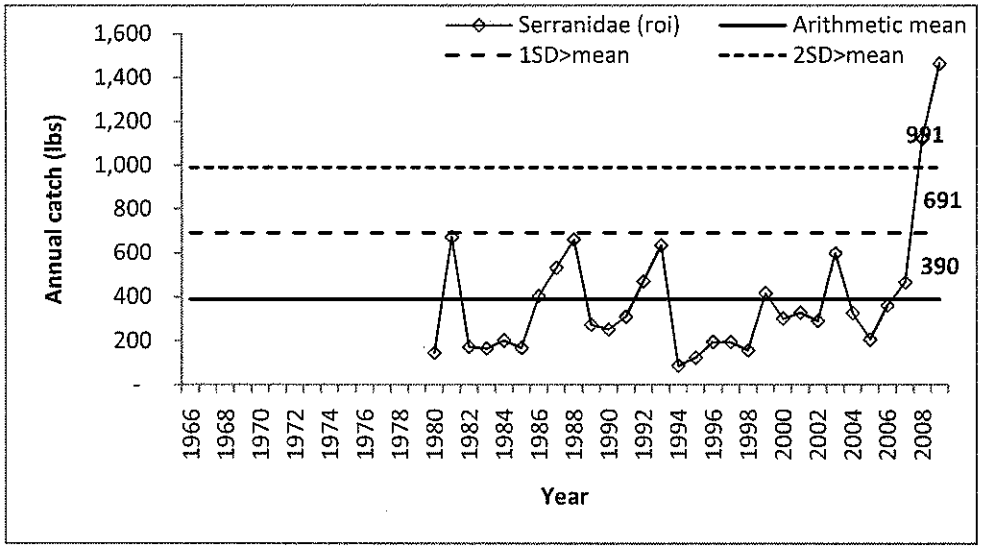


Figure 91. Temporal trend in annual catch of Serranidae (roi only) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

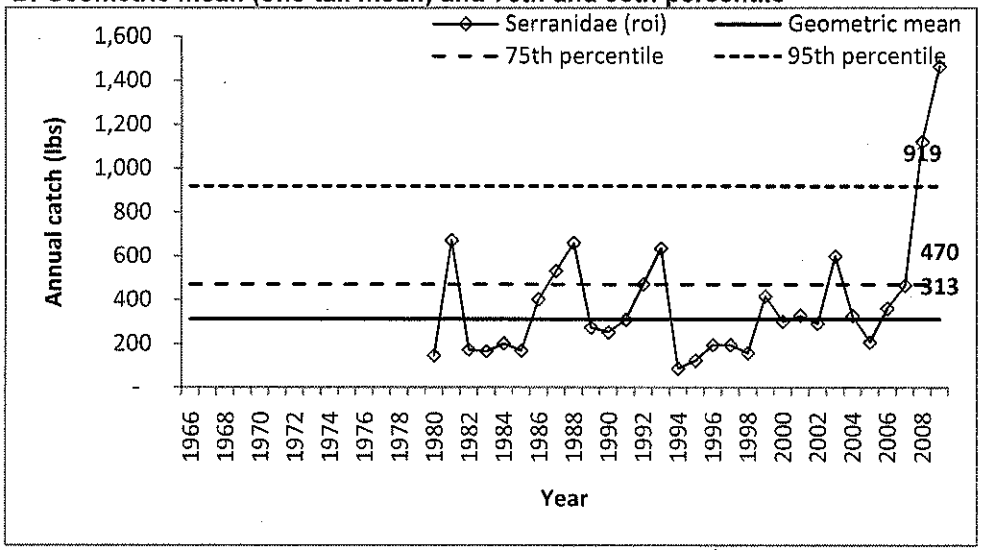
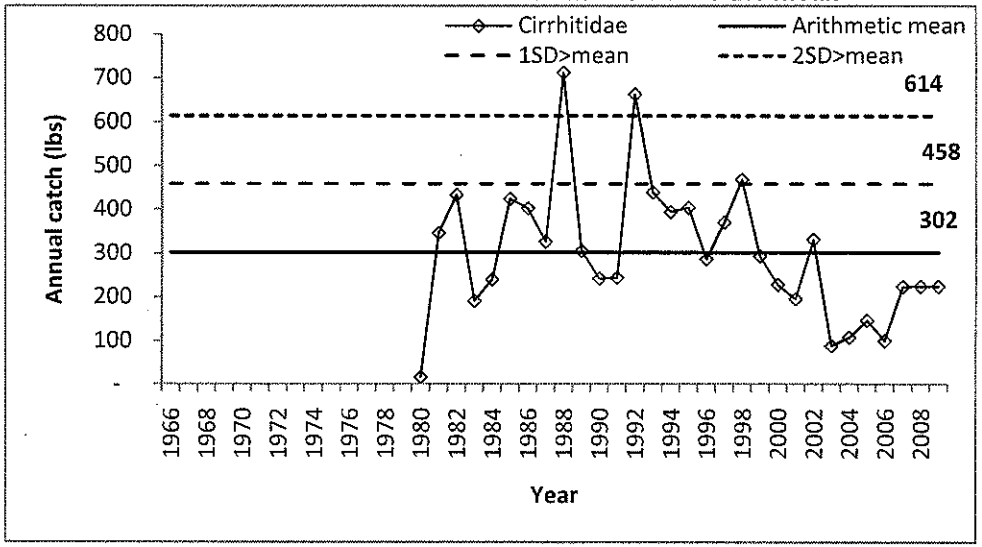


Figure 92. Temporal trend in annual catch of Cirritidae (hawkfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

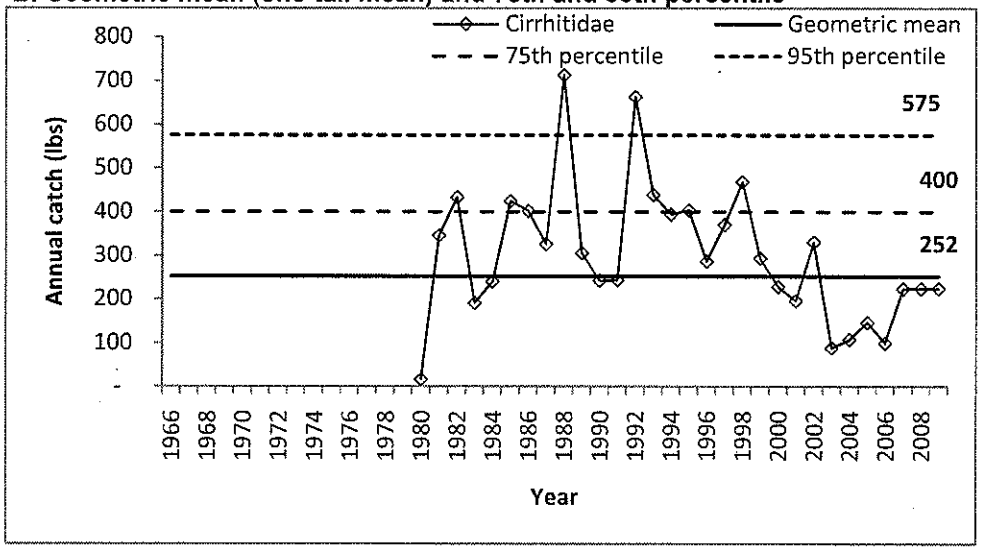
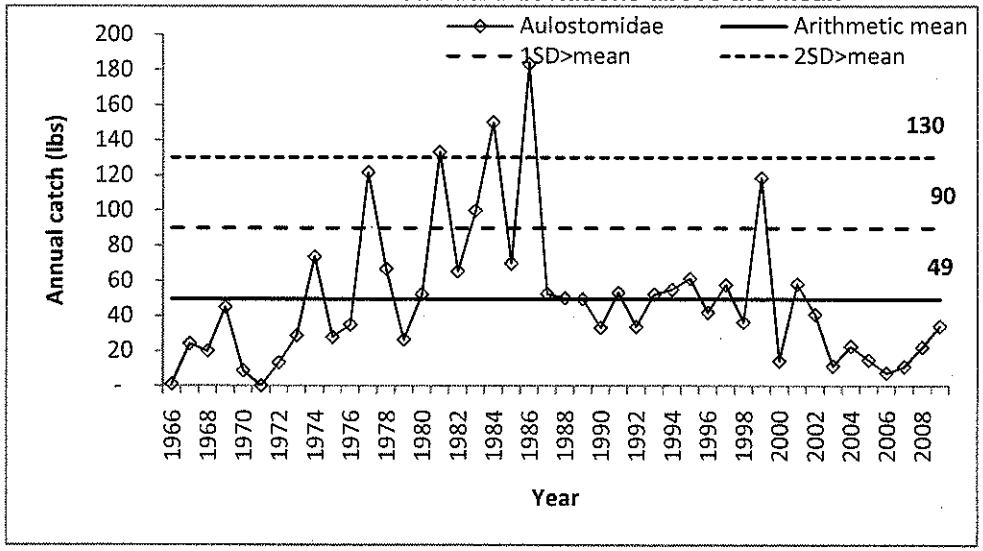


Figure 93. Temporal trend in annual catch of Aulostomidae (trumpetfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

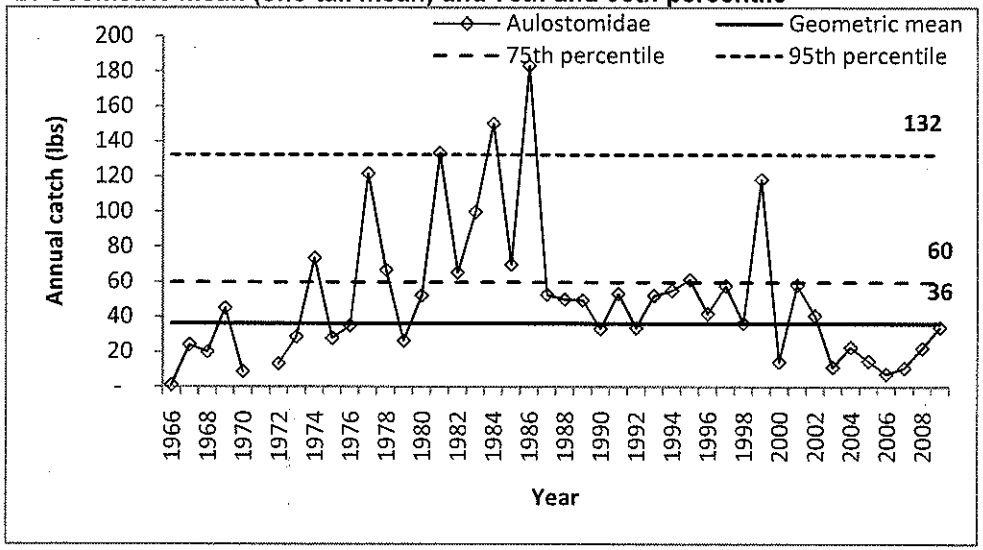
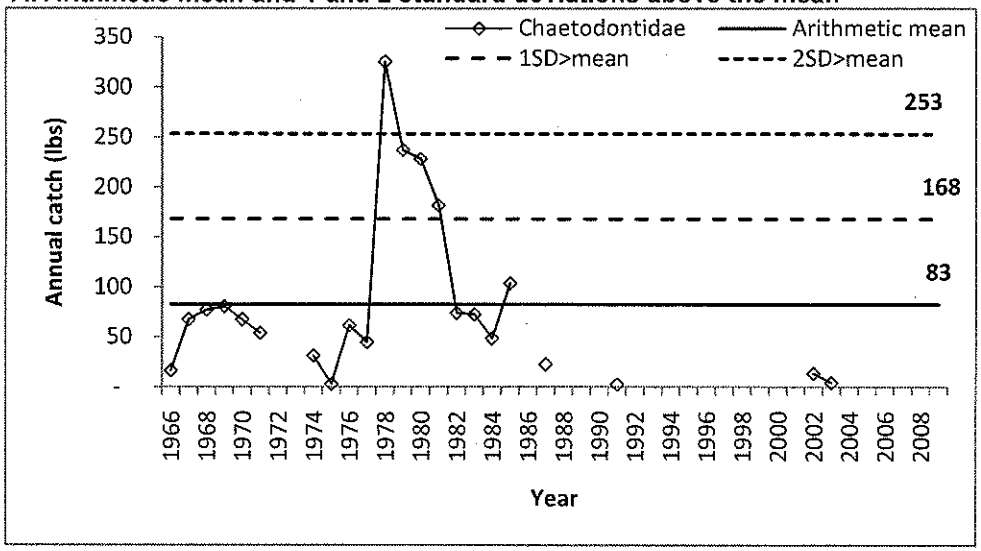


Figure 94. Temporal trend in annual catch of Chaetodontidae (butterflyfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

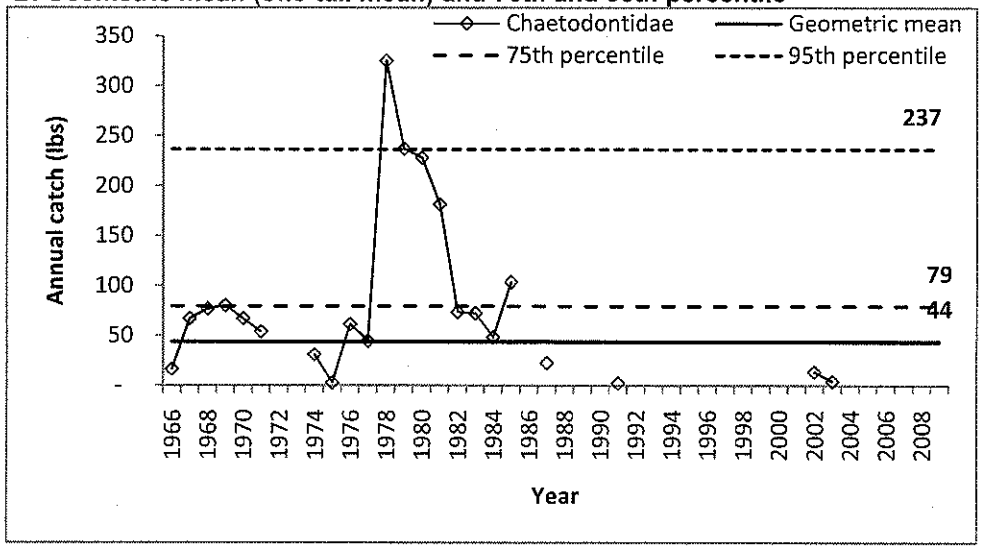
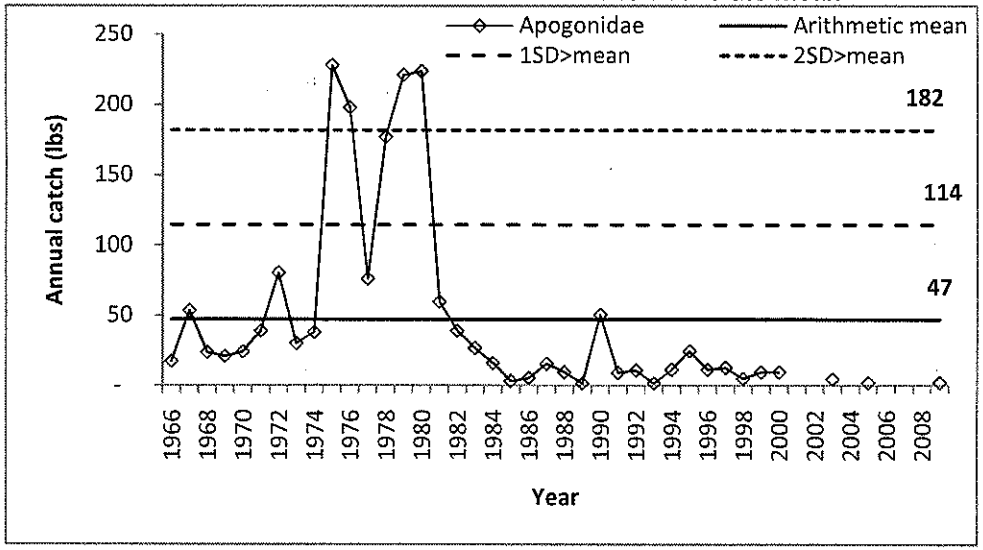


Figure 95. Temporal trend in annual catch of Apogonidae (cardinalfish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

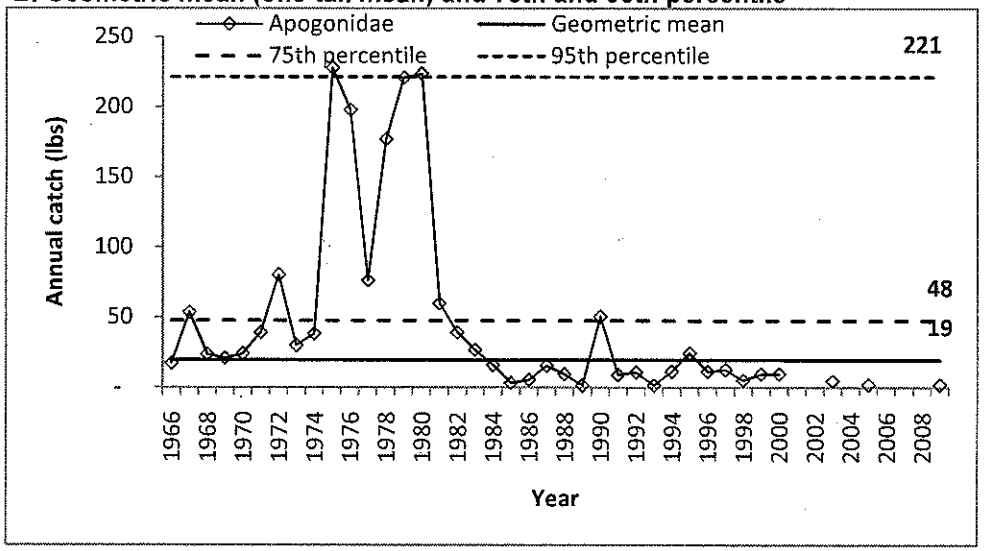
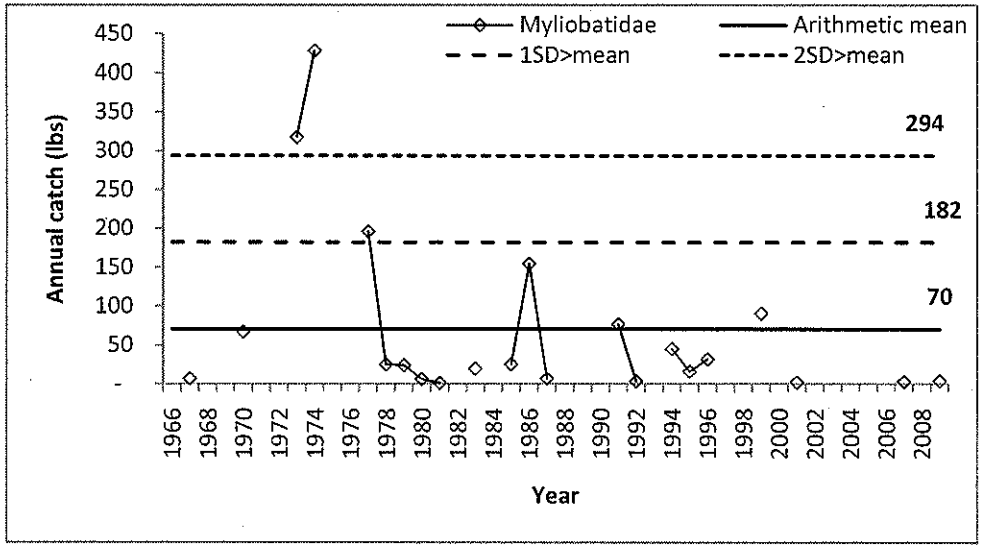


Figure 96. Temporal trend in annual catch of Myliobatidae (eagle rays) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

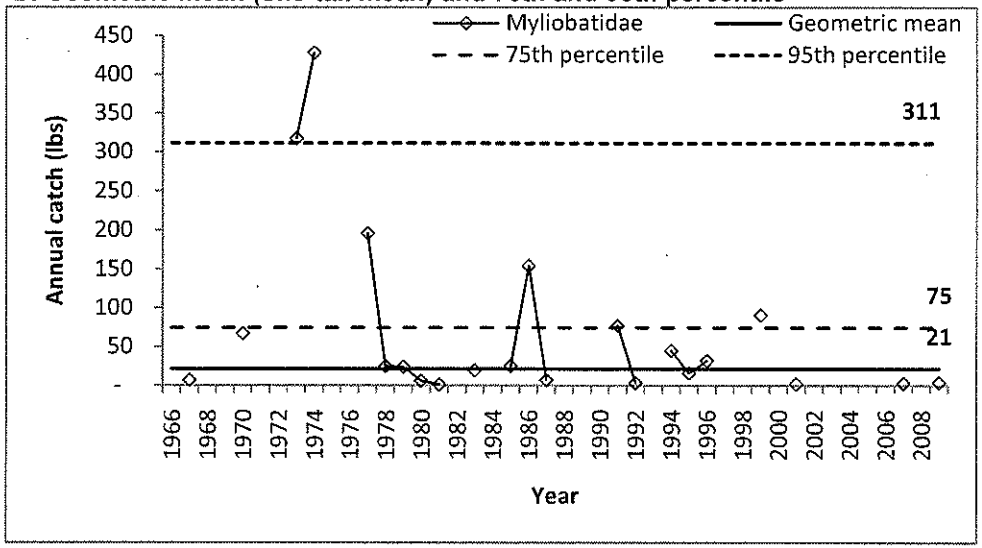
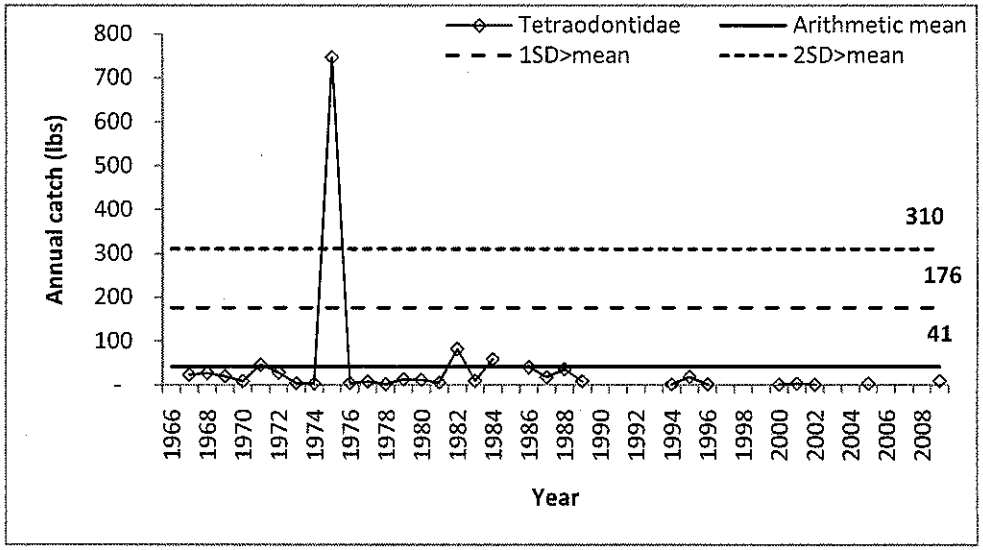


Figure 97. Temporal trend in annual catch of Tetraodontidae in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile

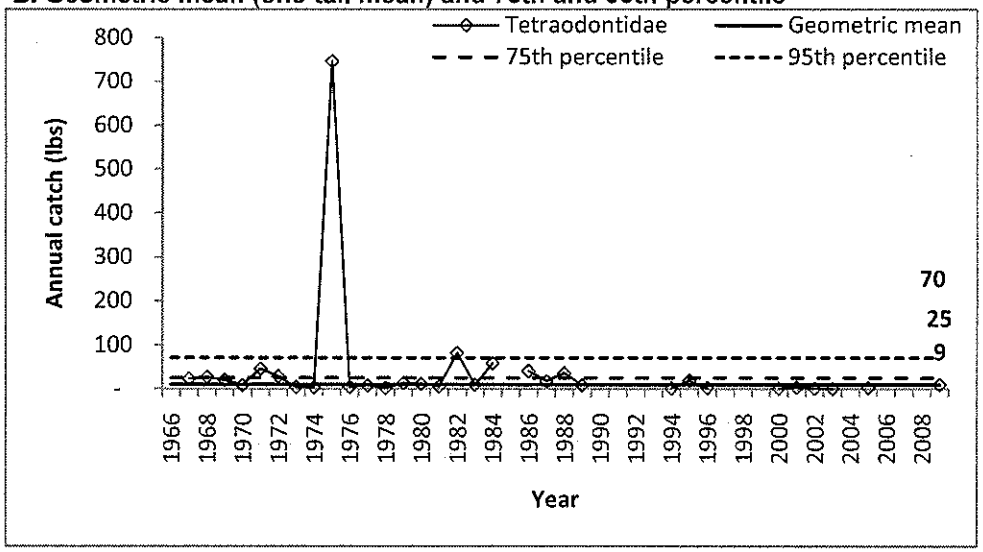
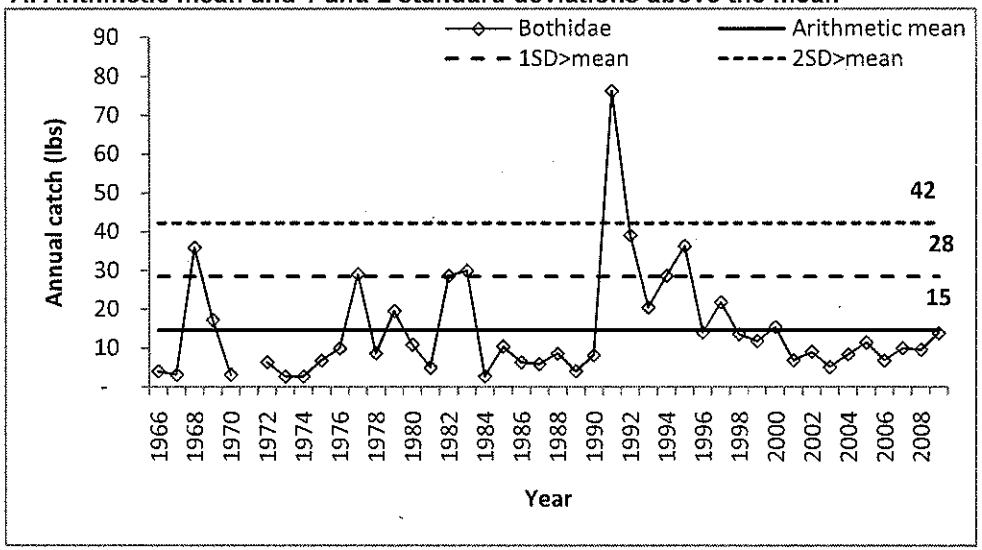


Figure 98. Temporal trend in annual catch of Bothidae (solefish) in Hawaii showing 2 types of central tendencies and variations.

A. Arithmetic mean and 1 and 2 standard deviations above the mean



B. Geometric mean (one-tail mean) and 75th and 95th percentile