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Natural Resource Stewardship and Science

Pacific Islands Stream Monitoring Protocol: Fish, Shrimp, Snails, and Habitat Characterization

Pacific Island Network

Natural Resource Report NPS/PACN/NRR—2011/468

ON THE COVER

NPS Photos – clockwise from upper left: *Macrobrachium latimanus* in the National Park of American Samoa, *Lentipes concolor* in Kalaupapa National Historical Park, *Neritina granosa* in Kalaupapa National Historical Park, Waikolu stream in Kalaupapa National Historical Park.

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Standard Operating Procedures

The following section consists of 35 Standard Operating Procedures (SOPs) that provide comprehensive instructions for all aspects of conducting a monitoring program for stream macrofauna (fish, shrimp, and snails) and habitat characteristics of Pacific Island Network (PACN) National Parks. Included are SOPs on pre-season preparation; field surveys of fish, shrimp, and snails; habitat characterization; data management, data analysis and report preparation; and post-season activities. Appendices related to these SOPs include site maps, species identification guides, and data sheets for each monitoring activity.

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Abstract

Throughout the world, freshwater ecosystems are considered to be among the most vulnerable systems. In the isolated Pacific islands there are a relatively small number of native freshwater species, which are mainly endemic to these locations (found nowhere else in the world). These species are characterized by an amphidromous lifecycle; reproducing in the stream, with larvae drifting to the ocean and eventually returning to a stream as juveniles and spending the remainder of their lifecycle there. Throughout the region, native flora and fauna face significant threats from species introductions and habitat destruction. The National Parks in the Pacific Island Network (PACN) protect some of the last relatively pristine stream systems. Monitoring based on this protocol: *Pacific Islands Stream Monitoring: Fish, Shrimp, Snails and Habitat Characterization*, will provide park managers with some of the information necessary to understand status and trends in biotic integrity within park stream systems.

Vital Signs are physical, chemical, and biological elements and processes of ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values. Two vital signs associated with freshwater ecosystems were identified by the PACN network: *Freshwater Animal Communities—Streams* and *Freshwater Animal Communities—Anchialine Pools.* This protocol is specific to stream systems and a separate protocol is being developed for anchialine pools. The *Freshwater Animal Communities: Streams* Vital Sign is closely linked with the *Water Quality* Vital Sign, and monitoring efforts will be conducted in tandem to enhance the value of the data collected.

The *Pacific Islands Stream Monitoring Protocol* will be implemented in four PACN parks: the National Park of American Samoa in American Samoa, War in the Pacific National Historical Park in Guam, Haleakala National Park in Hawaii, and Kalaupapa National Historical Park in Hawaii. This protocol is designed to address two monitoring objectives: 1) Determine long-term trends in population distribution and abundance, and community composition of freshwater fish and invertebrates (including snails and crustaceans) and 2) Quantify associations among stream animal communities (fish and invertebrates) and their habitat by correlating physical and chemical habitat measures with observed species distribution and abundance.

This protocol employs a split-panel design with both fixed (sampled every year) and random (new each year) stations that are sampled annually. This design provides both status and trend information, and enhances the ability to use the data to conduct trend analyses. This design also maximizes the statistical power to detect change over time by providing the ability to conduct parameter corrections based on repeat analyses. Both native and introduced fish, shrimp, and snail abundances will be monitored at selected sites along each stream. In addition, quantitative and qualitative physical habitat information will be recorded. Water quality and discharge will also be measured at each sampling station; methods are described in a separate protocol.

Chapter 1: Background and Objectives

Overview

National Park managers across the country are confronted with increasingly complex and challenging issues that require a broad-based understanding of the status and trends of each park's natural resources as a basis for making decisions, working with other agencies, and communicating with the public to protect park natural systems and native species. The Natural Resource Challenge, initiated in 1999 under the auspices of the Omnibus Act (1998), is an action plan for preserving natural resources throughout the National Park Service (NPS) system. As part of this plan, the NPS established 32 Inventory and Monitoring (I&M) networks across the nation, encompassing 270 National Parks. A primary role of the I&M Program is to collect, organize, and make available, natural resource data by facilitating the transformation of data into information through analysis, synthesis, and modeling. Ultimately natural resource inventory and monitoring information will be integrated into National Park Service planning, management, and decision-making.

Standardized protocols are being developed by the I&M Program to facilitate long-term monitoring of important resources (Vital Signs) which will serve as indicators of ecosystem status within National Parks. The ability of a monitoring program to detect the ecological effects of anthropogenic stressors is dependent upon interpreting trends in resource condition against the backdrop of intrinsic variation. To enhance understanding of these processes, conceptual models have been developed to summarize how natural drivers (e.g., climate variability, Figure 1.1) and anthropogenic stressors (e.g., stream flow alteration or invasive introduced species, Figure 1.2) affect aquatic ecosystem structure and functioning. Data collected following the *Pacific Islands Stream Monitoring Protocol* will identify associations between biotic stream communities and habitat conditions that can be linked to key drivers and stressors in the system. Over time, this data will provide park managers with information on the long-term status and trends of aquatic resources relative to natural processes and anthropogenic stressors, and will serve as a tool to evaluate the effectiveness of management actions aimed at protecting or restoring aquatic ecosystems.

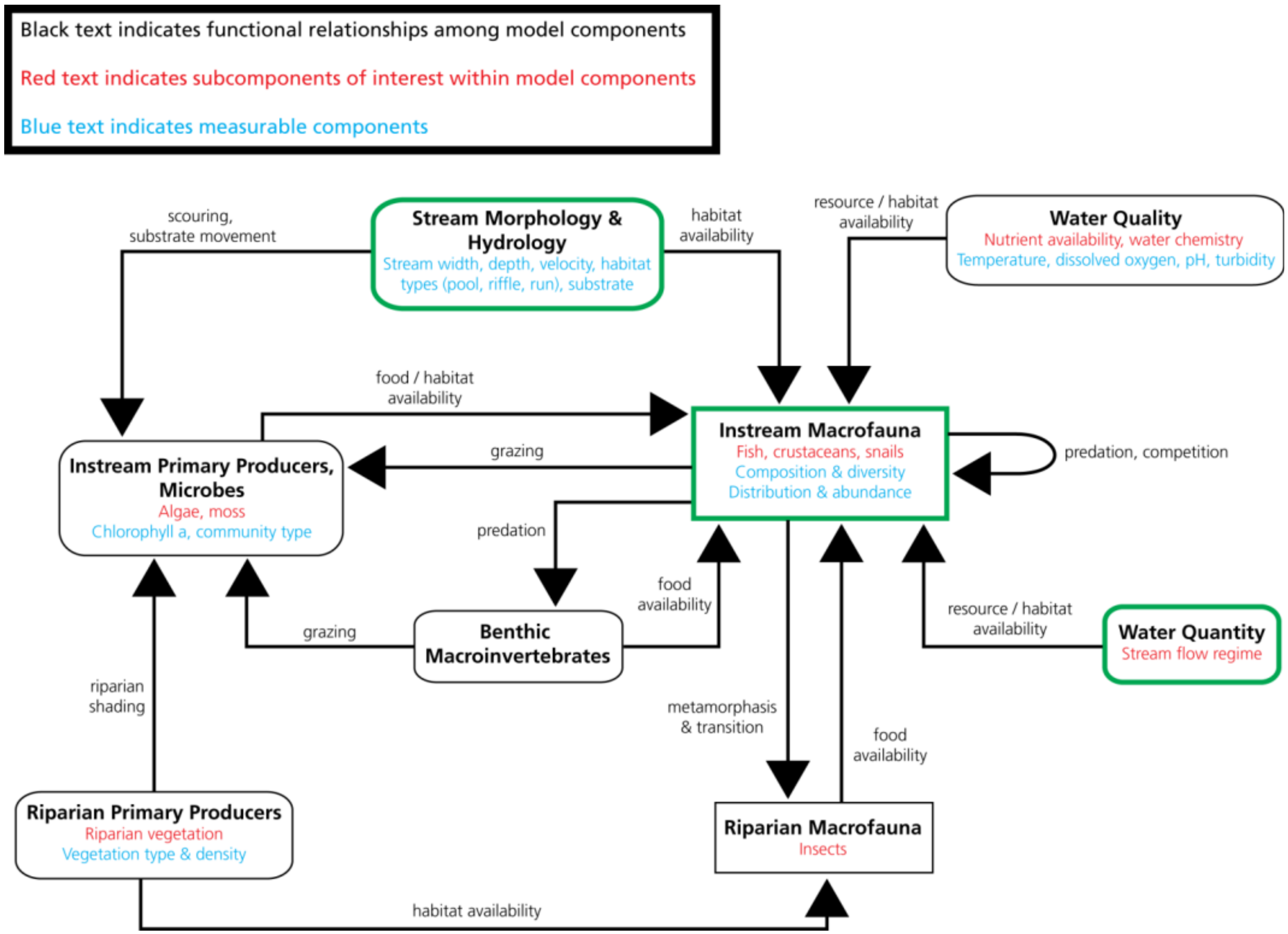

Figure 1.1. Conceptual model describing general ecosystem functioning. Green boxes indicate vital sign components that are part of this protocol.

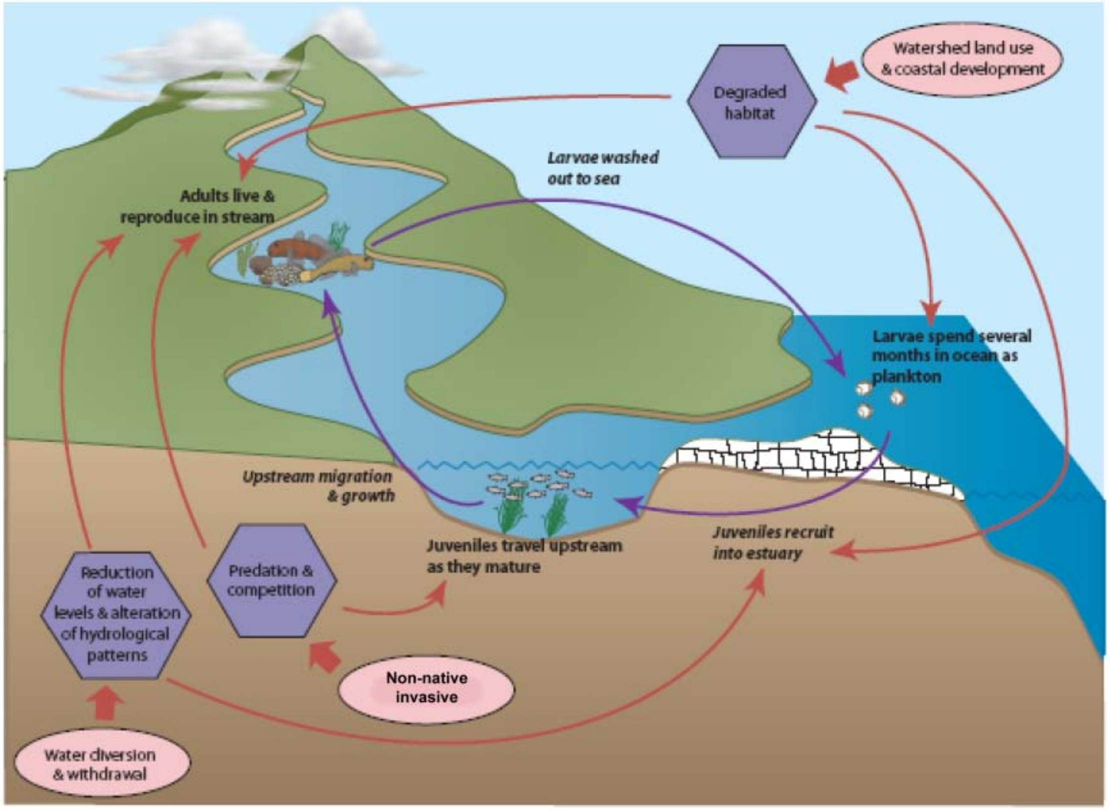

Figure 1.2. Potential anthropogenic stressors during the lifecycle of native stream organisms.

Eleven National Park units across the Pacific (Figure 1.3) form the Pacific Inventory and Monitoring (I&M) Network (PACN). The PACN covers a large geographical area in the tropical Pacific Ocean that is governed by four different entities: the Territory of American Samoa, the Territory of Guam, the State of Hawaii, and the Commonwealth of the Northern Mariana Islands (CNMI). National Park Service managers from the PACN identified freshwater animal communities as a key indicator (vital sign) of ecosystem health. Freshwater ecosystems in these parks include both anchialine pool systems (covered in a separate protocol) and stream systems. This protocol for stream ecosystems focuses on fish, shrimp, and snails, the key macrofauna in Pacific island streams. As part of the I&M monitoring program, both the status of these biota, and information on their physical and chemical habitat conditions will be recorded. Stream monitoring will be co-located in time and space with water-quality monitoring. To guide the monitoring process, this protocol consists of (1) a narrative with background information on Pacific stream systems, their unique fauna, a discussion of threats to these systems, the importance of monitoring streams, and how monitoring results can be used in a management context, (2) 35 Standard Operating Procedures (SOPs) that provide specific guidelines for conducting the monitoring program (including field activities, data management, and report preparation), and (3) a supplemental information section with 16 appendices (analysis of existing data, details on operational requirements, species identification guides, data sheets, site specific information including maps with station locations, Park and other contacts, and data management).

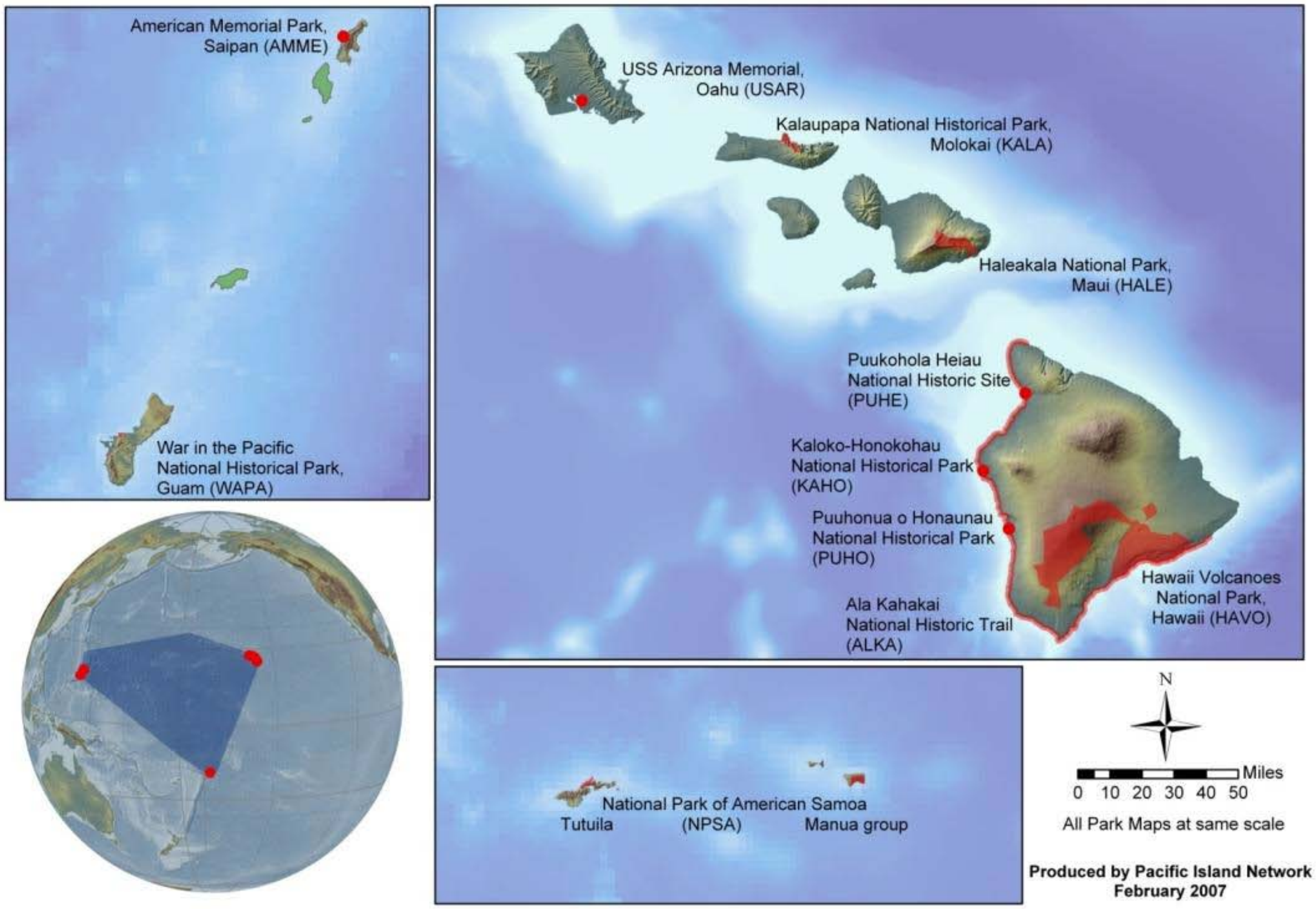

Figure 1.3. Map showing the geographical region of the 11 Pacific Island Network park units. Red areas on the maps represent the location of each National Park.

Stream Fauna of Tropical Pacific Islands

Life History Characteristics

Native stream fishes and the larger crustaceans and mollusks in tropical Pacific island streams are derived from stream species elsewhere in the Indo-Pacific, which in turn originally derived from marine species. These species have retained an oceanic larval life stage (McDowall 2003). In this type of diadromy (called amphidromy), where part of the life cycle is spent in the stream and part in the ocean (Figure 1.4), the adult life is spent in streams, and larval periods are spent as marine or estuarine zooplankton (Ford and Kinzie 1982, Kinzie 1988, McDowall 1988, 2003, Radtke et al. 1988). Some studies have indicated a seasonal (Ego 1956, Ha and Kinzie 1996, McDowall 1995, Resh et al. 1990, 1992) or lunar (Erdman 1986) periodicity for freshwater gobies and crustaceans. Many species appear to have multiple periods of reproduction throughout the year (Manacop 1953, Couret 1976, Kinzie and Ford 1982, Kinzie 1990, 1993, Bell and Brown 1995, Lindstrom 1998). In certain locations, some species appear to spawn seasonally while others reproduce throughout the year (Resh et al. 1992, Brasher 1997c). Genetic studies on some of the Hawaiian amphidromous gobies (Fitzsimons et al. 1990) and neritid snails (Hodges 1992) indicate that adult populations are genetically undifferentiated throughout their range, recruitment is from a well-mixed pool of larvae, and that larvae do not return to their natal streams.

Adults of these amphidromous species reproduce in upstream habitats, and the larvae drift downstream into estuaries or the ocean, eventually returning to the stream as bottom-dwelling postlarvae and migrating upstream to grow and reproduce (Kinzie 1990, 1993). Newly hatched fish and shrimp larvae drift downstream and maintain position in the water column by alternatively swimming upward and passively sinking back down as they are carried toward the sea (Bell and Brown 1995, Lindstrom 1998). Larvae that successfully drift to the ocean spend from 1 to 5 months as plankton before recruiting back to fresh water (Radtke and Kinzie 1987, Radtke et al. 1988, Benstead et al. 1999). This relatively long oceanic larval stage may be due to the amount of time required to locate a freshwater settlement site as well as the developmental complexities required to complete the marine-to-freshwater transition (Bell et al. 1995, Radtke et al. 2001). A critical feature of the amphidromous life cycle is the need for unimpeded access to and from the ocean for downstream dispersal of larvae and upstream migration of postlarvae (Resh et al. 1992, McDowall 1995, Brasher 1996, Benstead et al. 1999, Fitzsimons et al. 2002, McIntosh et al. 2002).

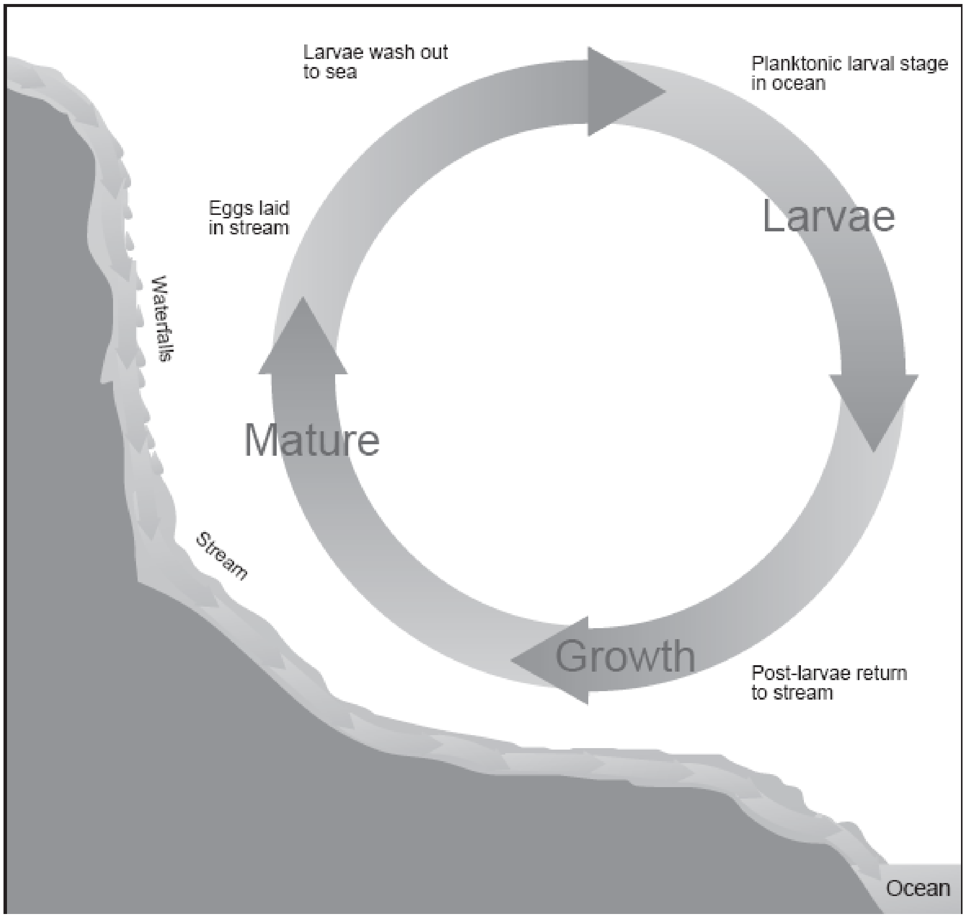

Figure 1.4. Amphidromous life cycle of fish, shrimp, and snails.

Fauna of Hawaii, American Samoa, and Guam

The stream fauna that are the focus of this protocol include native fishes of the families Anguillidae, Eleotridae, Gobiidae, and Kuhliidae, crustaceans (shrimp and prawns) of the families Atyidae and Palaemonidae, and snails of the family Neritidae. Introduced fish, shrimp, and snails will also be monitored when they occur at a site. However, with the exception of *Macrobrachium lar* (a widespread introduced prawn), introduced species are not described in this protocol. The majority of studies on Pacific island stream fauna have been conducted in Hawaii, and consequently substantially more information is available for the Hawaiian Islands than for either American Samoa or Guam. When possible, ecologically relevant and phenotypic information for a given species is included. However, when this information is not readily available, a list of known species is provided. Morphometric characteristics are described below, when available. Key characteristics of the crustaceans include the carapace (exoskeleton), pereiopod (thoracic appendage), and carpus (a segment of the pereiopod). Picture guides to all of the native fauna are available in Appendices #1-3. Pictures of the more common introduced species are included in Appendix #4: “Introduced Species Identification Guide.” Excellent field guides have been published for American Samoan (Vargo 2009) and Hawaiian (Yamamoto and Tagawa 2000) stream fauna.

American Samoa

Published information is only available on some of these species, and is provided below. Photos to assist in identification are provided in Appendix 1. The majority of information on fish, shrimp and snails in American Samoa is taken directly from Vargo 2009.

Fish

Family: Anguillidae

There are three anguillids (eels) reported for American Samoa including: *Anguilla marmorata*, *Anguilla megastoma*, and *Anguilla obscura*. These anguillids can reach lengths of 100 cm or more.

A. marmorata, the giant mottled eel, can be readily distinguished from other eels by its mottled color and dorsal fin position, which is more anterior than other *Anguilla*. Adults have black or brown marbling on their backs with a grey-yellow background; marbling is harder to see on young eels. They reach two meters and 20.5 kilograms and typically have 100-110 vertebrae.

A. megastoma can be either plain or mottled in color. *A. megastoma* has 110-114 vertebrae, which is more than the other two anguillids.

A. obscura is always plain in color and has 102-108 vertebrae.

Family: Eleotridae

Eleotris fusca is the only eleotrid (sleeper fish) reported for American Samoa. They are dark brown to black in color with horizontal lines on body and spots on fins of juveniles. This fish lacks the fused pelvic fins of the gobies, and therefore is only found below the first waterfall. Commonly 10–15 cm in length but can grow as large as 26 cm. This amphidromous fish lives in brackish and freshwater habitats. Adults occur in streams (usually mud bottoms of lower reaches), estuaries, and lagoons. Juveniles are usually found in the more saline areas of estuaries and lagoons among mangrove roots. Their diet includes benthic animals (fish, crustaceans, and insects). *E. fusca* lays its eggs on submerged plants with small leaves.

Family: Gobiidae

There are nine species of gobies found in American Samoa including: *Awaous ocellaris*, *Periophthalmus kalolo*, *Periophthalmus argentilineatus*, *Periophthalmus koelreuteri*, *Sicyopterus caeruleus*, *Stiphodon elegans*, *Stiphodon hydoreibatus*, *Sicyopterus micrurus*, and *Sicyopterus pugnans*. Published information is only available on some of these species, and is provided below.

A. ocellaris may grow to 8-13 cm and is found in estuarine environments and often burrows into sandy substrates with only its eyes showing. Its diet includes green filamentous algae, worms, small crabs, shrimps, and various insects.

*P. kalolo g*rows to 10-12cm length. *P. kalolo* is an amphibious air-breathing gobiid that spends the majority of its time out of water. In order to breathe *P. kalolo* needs to stay wet, and therefore is typically found resting on mud, rocks, or mangrove roots with its tail dipped in water. This species feeds on worms, small crustaceans, and insects.

S. caeruleus has a horseshoe-shaped band on its tail fin; however, this may be difficult to see. Males can grow up to 6-7 cm, and larger males have scales embedded in a spongy tissue just before the tail fin. *S. caeruleus* was previously identified as *S. lagocephalus* and is commonly referred to as *S. macrostetholepis* or *S. taeniurus* in the literature.

S. elegans males often have neon green spots and reach a maximum size of 5 cm. Females are golden-brown in color. This fish is found in a variety of stream habitats, especially in fast flowing water. This species is generally found near the substrate and feeds on algal films covering rocks.

S. hydoreibatus is easily mistaken for *S. elegans* but is about half the length of *S. elegans*.

Family: Kuhliidae
The two species of kuhliids reported for American Samoa include: *Kuhlia rupestris* and *Kuhlia salelea*.

K. rupestris is identified by two separate dark spots on the caudal fin (one dorsal and the other ventral). This fish can get as large as 45 cm, with an average weight of 50 g. This fish is widely distributed throughout the streams in American Samoa and is a top predator in many ecosystems, feeding on crustaceans and insects. *K. rupestris* can swim upstream through fast-flowing cascades. .

K. salelea can be identified by a continuous dark border running along the trailing edge of its tail fin. *K. salelea* is smaller (approximately 17 g) than *K. rupestris*, but may be more abundant in some stream reaches. *K. salelea* has a more restricted range than *K. rupestris* and is known only to occur in streams on Tutuila Island and Upolu Island.

Fish that are reported to inhabit Laufuti Stream on Tau include *A. marmorata, A. megastoma, E. fusca, S. pugnans, S. micrurus, and S. elegans* (Cook 2004).

Crustaceans
Shrimp and prawns are referred to as Ula Vai in American Samoa.

Family: Atyidae
There are five species of atyids (shrimp) reported for American Samoa including: *Atyoida pilipes*, *Atya serrata*, *Atyopsis spinipes*, *Caridina serratirostris*, *Caridina typus*, and *Caridina weberi*.

A. pilipes do not have a carapace spine, and the width of the carpus of the second pereiopod is greater than the length. Individuals can grow to be 4-5 cm in length and females are significantly larger than males. Juveniles can often be found buried within the substratum in the lower reaches to avoid predators. Adults are commonly seen in upper reaches above barrier waterfalls, prefer hard substrates in riffle areas, and have long setae well suited for filter-feeding in fast moving water.

A. spinipes has phenotypic characteristics similar to those of *A. pilipes*. The easiest way to distinguish between the two is that *A. spinipes* has a lateral striping pattern along the carapace and abdominal segments. Additionally, *A. spinipes* has a carapace spine on the anterior of the carapace. Similar to *A. pilipes*, the width of the carpus of the second pereiopod is greater than the length. *A. spinipes* can grow to 4-5 cm. This species has brushes on its chelae to aid in filter feeding.

C. serratirostris is 10-15 mm and has brushes on its chelae. The length of the carpus of the second pereiopod is greater than the width. The upper edge of the rostrum has teeth and extends backward for at least half the carapace length, well behind the eyes.

C. typus is 10-15 mm and has brushes on its chelae. The length of the carpus of the second pereiopod is greater than the width, and the upper edge of the rostrum does not have teeth. This is the least common of the *Caridina* species found in American Samoa.

C. weberi is 10-15 mm in length with brushes on its chelae. Similar to the other *Caridina* spp. the length of the carpus of the second pereiopod is greater than the width. The upper edge of the rostrum has teeth that extend backwards no further than the eye. This is the most common *Caridina* species found in American Samoa.

Family: Palaemonidae

There are five species of palaemonids (prawns) reported in American Samoa, all of the genus *Macrobrachium*. They include *M. australe*, *M. gracilirostre*, *M. hirtimanus*, *M. lar,* and *M. latimanus*. *M. lar* is an introduction from Tahiti.

M. australe have a “glassy” or transparent body and most larger specimens show three brown vertical stripes on each side of the carapace and one stripe forward of these three, but at an angle. The carpus of the second pereiopod is longer than the merus.

M. gracilirostre has conspicuous brown and blue stripes. However, when viewed from above the tan saddle behind the carapace is the most obvious marking. The length of the carpus of the second pereiopod is equal to the length of the merus.

M. hirtimanus - Vargo (2009) warns that *M. hirtimanus* very much resembles *M. gracilirostre* and *M. lepidactyloides*. It was reported to be found in Laufuti Stream on Tau (Cook, 2004).

M. lar, an introduced prawn, may grow up 15 cm in length, and are brownish with long, thin dark pincer legs and 8 or 9 spines on the dorsal surface of the rostrum.

M. Latimanus is approximately 10 cm in length. The length of the carpus of the second pereiopod is shorter than the merus.

Snails

Neritid snails are referred to as Sisi Vai in American Samoa.

Family: Neritidae

There are seven species of snails in the family Neritidae in American Samoa, including: *Clithon corona*, *Clithon pritchardi*, *Neritina auriculata, Neritina canalis, and Neritina variegata*, *Septaria sanguisuga*, and *Septaria suffreni*. The shells of adult snails of all seven species are approximately 1 cm in width.

C. corona has a rigid, brown to dark brown shell. Their shell lip and inner shell lining are white. The color of the operculum is similar to the shell, with a narrow orange-brown horn border. Smaller and younger specimens often have spines on their shells.
This common species found on rocks in pools and in flowing water anywhere along the stream length.

C. pritchardi has a brown shell that is roughly wrinkled (distinguishes this species from *C. corona*), and may or may not have spines. The shell lip is white to orange-yellow, and the inner shell lining is white. The color of the operculum is similar to the shell with a narrow orange-brown border. This common species is found on rocks in pools and flowing water anywhere along the stream length.

N. auriculata has a light brown shell with no obvious pattern which is often extended at the sides to form wings. The shell lip is cream to grey in color. Their operculum is cream to dark brown with gray radial lines and a red outer horn border. This species is restricted to estuarine environments where it can be found on rocks or sandy substrates.

N. canalis has a brown to black shell with a shell lip and inner shell lining that are orange-yellow to red. This relatively uncommon species is found on stones in flowing water.

N. variegata has a shell that ranges in color from olive to dark brown with a shell lip and inner shell lining that are white with a reddish splash on the shell lip. The operculum is white to black with no horn border. This species has been found in flowing water as well as in mud flats.

S. sanguisuga has a dark brown shell that is oblong-ovate, and sometimes has a fine network of black lines. The shell lip is tinged orange and the inner shell lining is white. The operculum is internal and orange in color with two horns of nearly equal length. The fleshy foot of this species is pale yellow. This uncommon species can occasionally be found on rocks in flowing water, and is usually found on walls of waterfalls.

S. suffreni has a yellow-brown shell that is oblong-ovate, and has variable markings ranging from traverse wavy lines to triangles, or zig zags. The shell lip is often tinged yellow to orange. The operculum is internal, orange, and has one horn. The fleshy foot of this species is gray. This common species is found on rocks in pools and flowing water.

Guam

Fish

Family: Anguillidae
Anguilla marmorata is described above in section on fish in American Samoa.

Family: Eleotridae
Eleotris fusca is described above in the section on fish in American Samoa.

Family: Gobiidae
Freshwater gobies are referred to as Atot in Guam. There are a number of native gobies in Guam including: *Awaous guamensis*, *Mugilobius cavifrons*, *Sicyopterus lagocephalus*, *Sicyopterus macrostetholepis*, *Sicyopus leprurus*, *Stiphodon elegans*, and *Stiphodon percnopterygionus*. Some of these species are described below.

A. guamensis are typically found in deeper slower moving waters (Ego 1956; Kinzie 1988). The species is an omnivore; filamentous algae make up approximately 84% of the gut volume and animal matter, especially chironomids, the other 16% (Ego 1956; Kido et al. 1993).

S. lagocephalus is on average 10-12.5 cm in length and is usually found in upper reaches, on hard substrates, and in strong currents. *S. lagocephalus* is herbivorous.

S. macrostetholepis is generally about 10 cm in length.

S. elegans is described above in the section on fish in American Samoa.

S. percnopterygionus has an average length of 2.5 cm and is usually found in shallow upper reaches on hard substrates. This species is herbivorous.

Family: Kuhliidae
Kuhlia rupestris is described above in the section on fish in American Samoa.

Crustaceans
Both freshwater and marine crustaceans are referred to as Uhang in Guam.

Family: Atyidae

The people of Guam, Chamorros, traditionally harvested stream atyids and prepared them in a dish called kélaguen. There are six species of atyid shrimp found in Guam including: *Antecaridina lauensis*, *Atyoida pilipes, Caridina brachydactyla, Caridina mertonia, Caridina typus,* and *Halocaridinides trigonophthalma*.

Atyoida pilipes is described above in the section on shrimp in American Samoa. It is the most common species of shrimp in the streams of Guam.

Caridina shrimp have both long and short setae enabling them to feed by scraping and filtering in a wide range of habitats. Species in this genus are commonly seen in pools and runs of streams.

Halocaridinides trigonophthalma and *Antecaridina lauensis*, two other species of atyids, have red integumentary chromatophores and feed mostly by scraping the substrate. They are able to adapt to a wide range of salinities and are commonly found in interstitial habitats such as fissures, pools, and wells.

Family: Palaemonidae
Macrobrachium lar is present in many streams on Guam. *M. lar* is an introduction from Tahiti. Additional information on *M. lar* characteristics can be found in the section above describing stream fauna in American Samoa.

Snails
Neritid snails are referred to as Akaleha in Guam.

Family: Neritidae
There are at least three native neritid snails in Guam, including *Neritina pulligera*, *Neritina squamipicta, and Neritina variegata.* Detailed information on the phenology and habitat preferences of these species is currently unavailable.

Hawaii

Substantially more information on the ecology and life-history characteristics is available for the Hawaiian taxa than for the stream organisms in American Samoa or Guam. In addition to morphometric descriptions of the various species, ecological information is provided when available.

Fish

Hawaiian stream gobies are known to separate out along the gradient from mouth to headwaters (Brasher 1996). The eleotrid (*Eleotris sandwicensis*) and one goby (*Stenogobius hawaiiensis*) are only found in estuaries or below the first waterfall. *Awaous guamensis*, the largest goby, tends to be found in lower reaches, especially in streams with precipitous waterfalls. *Sicyopterus stimpsoni* often overlaps with *A. guamensis* but may be found farther upstream as well. *Lentipes concolor* is found at the highest elevation of all the gobies. The number and relative gradient of waterfalls appear to play an important role in the overall distribution of species. In streams with a terminal waterfall *L. concolor* can be found near the ocean (Nishimoto and Kuamoo 1991), while in streams with relatively low gradient and no major waterfalls *A. guamensis* can be found farther upstream.

Family: Gobiidae
Gobies are referred to in Hawaii as Oopu. There are four species of gobies in Hawaii. They include *Awaous guamensis*, *Lentipes concolor*, *Sicyopterus stimpsoni*, and *Stenogobius hawaiiensis*. Originally from Guam, *A. guamensis* is considered indigenous to Hawaii (native to Hawaii, but not endemic, which would mean it is found nowhere else).

A. guamensis is the most common Hawaiian freshwater goby and is found in lower and middle stream reaches (Ford and Yuen 1988). This species is found on all the major islands, although on Oahu the population sizes are small and the number of streams inhabited are few (Kinzie 1990). A fishery exists for *A. guamensis* on the island of Kauai, where they are caught in large numbers during the annual spawning run to the stream mouth following heavy fall flooding. *A. guamensis* probably competes with *L. concolor* for food, and to some extent space (Timbol et al. 1980). Further details on *A. guamensis* can be found above in the section on fish in Guam.

L. concolor is the least common freshwater goby in Hawaii (Timbol et al. 1980). Mature *L. concolor* typically reside in the middle to upper reaches of streams, although they can be found near the stream mouth in streams that end in terminal waterfalls (Maciolek 1977; Nishimoto and Kuamoo 1991). They appear to spend much more of their time in mid-water pools than other species (Kinzie and Ford 1982), although they also have a strong affinity for fast riffles (Timbol et al. 1980). *L. concolor* is known for its remarkable climbing ability and can be found at the highest elevation of any Hawaiian goby. Lau (1973) found the diet of *L. concolor* to consist of algae, insect larvae, and crustaceans, especially native mountain shrimp (opae). Larger gobies eat more animal material while smaller ones eat more algae (Lau 1973). Mature males are aggressive and show territorial behavior (Lau 1973; Maciolek 1977; Nishimoto and Fitzsimons 1986). Females tend to move freely up and down the stream and around pools, while males are very site specific and defend a discrete territory (Nishimoto and Fitzsimons 1986).

S. stimpsoni is also found in the mid to upper stream reaches, and tends to utilize more rapid stream velocities (Kinzie 1988). *S. stimpsoni* appear to be restricted to relatively undisturbed streams with good water quality and a high rate of discharge (Kinzie 1990). Tomihama (1972) reported that while *S. stimpsoni* can climb waterfalls, it is less adept than *L. concolor*. While the two species' distributions can greatly overlap, *L. concolor* may be found at higher reaches. A tagging study by Kinzie and Ford (1982) showed *S. stimpsoni* to show high site fidelity. It is herbivorous, feeding on diatoms and filamentous blue-green algae (Kinzie and Ford 1982; Tomihama 1972).

S. hawaiiensis possesses fused pelvic fins; however, the species is apparently neither a strong swimmer nor climber and occurs primarily along stream margins and other low flow areas near the stream mouth (Fitzsimons and Nishimoto 1991). *S. hawaiiensis* typically occurs in lower stream reaches and estuaries. *S. hawaiiensis* is the only Hawaiian goby that does not show strong territorial behavior (Fitzsimons and Nishimoto 1990). It has a planktonic marine larval stage of approximately 135 days (Radtke et al. 1988). *S. hawaiiensis* is omnivorous.

Family: Eleotridae

Eleotris sandwicensis lacks the fused pelvic fins characteristic of true gobies and thus is found only in stream reaches below the first precipitous waterfall (Fitzsimons and Nishimoto 1991; Kinzie and Ford 1982). The species is generally found in lower stream reaches and estuaries. *E.sandwicensis* is a predatory carnivore; gut content analysis of *E.sandwicensis* has shown them to prey on small benthic invertebrates, snails, shrimp, insects, and other fish (Kinzie and Ford 1982).

Crustaceans

Family: Atyidae

Atyid shrimp are referred to in Hawaii as opae. *Atyoida bisulcata* are small shrimp, up to three inches (8 cm). The species appears to have a blunt head and can be identified by their small bristled pincers. They can be found in habitats ranging from quiet pools to high velocity cascades and can be typically found in the upper reaches of streams (Couret 1976; Kinzie 1990). *A. bisulcata* inhabit all of the Hawaiian Islands and are harvested as a delicacy food and for bait.

Family: Palaemonidae

Macrobrachium lar were first introduced in 1956 into Pelekunu Stream on the island of Molokai; in 1957-1958 into Nuuanu Stream on Oahu, and in 1961 into Punaluu Stream on Oahu. They subsequently spread to every stream in Hawaii. Now they are found on all the major Pacific islands. Several researchers have indicated potentially negative impacts of *M. lar* on native goby and snail populations. Further details on *M. lar* characteristics are included above in the section on shrimp in American Samoa.

Snails
Family: Neritidae
Neritina granosa is a limpet-like snail that typically hides under boulders and in crevices during the day, coming out at night to forage and mate. They tend to be found in lower to mid-stream reaches and are collected by humans for consumption, although a ban on commercial sale went into effect in 1993. They require cool, clear, fast flowing and well-oxygenated water. They are uncommon in, or absent from, streams that are modified, degraded, and easily accessible by humans (Maciolek 1978). Relatively few streams in Hawaii contain substantial populations of *N. granosa* (Hawaii Stream Assessment 1990). Because they are relatively uncommon and require habitats typical of high quality streams (Ford 1979; Hathaway 1978; Hodges 1992; Maciolek 1978), *N. granosa* may serve well as an indicator species of habitat and water quality (Brasher 1997c).

Natural Drivers and Anthropogenic Stressors

As human population increases on islands across the Pacific, stream habitats and watersheds are undergoing substantial alteration, resulting in conditions that differ greatly from those that once sustained native stream communities (Brasher 2003). Because these ecosystems are located in some of the more rapidly developing areas in the world, pressure on their natural resources is intense. Land use changes result in habitat alteration and facilitate the establishment of invasive introduced species (Figure 1.4). Streams are particularly vulnerable because of the spatially concentrated human populations that characterize many of these island ecosystems (Smith et al. 2003). Human alteration of land and hydrologic systems on many tropical islands occurs primarily along the coastal perimeter. This impacts not only native fauna living in or migrating through these areas, but also humans that traditionally consume native species for subsistence (Resh and deSzalay 1995; Haynes 1999).

Extreme examples come from the Hawaiian Islands where large-scale urbanization and development has resulted in lower water quality and degraded physical habitats for many native stream species (Brasher 2003; Anthony et al. 2004; Brasher et al. 2004). Stream quality can be affected by stream channelization for flood control or roadways, increases in sedimentation from construction and farming, contaminants from agricultural, urban, and industrial activities that get transported in storm-water runoff, and diversions to redirect stream water to farms and other off-stream uses (Oki and Brasher 2003). Even in relatively pristine areas, water diversions may result in decreased flow and periodic dewatering of stream sections, reducing available habitat and inhibiting downstream dispersal and upstream migration of native species (Resh et al. 1990; McDowall 1995; Brasher 1997a; Benstead et al. 1999; Brasher 2003; March et al. 2003; Smith et al. 2003).

Of the five native amphidromous fishes (*E. sandwicensis, S. hawaiiensis, A. guamensis, S. stimpsoni* and *L. concolor*) in Hawaii, only the two species most tolerant of large variations in environmental conditions, *E. sandwicensis* and *S. hawaiiensis* (Hathaway 1978), are numerous in any Oahu streams (Hawaii Stream Assessment 1990; Kinzie 1990). The native fishes least tolerant to habitat degradation (Hathaway 1978; Kinzie 1990), *L. concolor* and *S. stimpsoni*, are rarely found on Oahu (Timbol et al. 1980; Fitzsimons et al. 1990; Higashi and Yamamoto 1993; Luton et al. 2005; Brasher et al. 2006). The two native (*M. grandimanus* and *A. bisulcata*) and one introduced (*M. lar*) amphidromous shrimp commonly occur in Oahu streams (Luton et al. 2005; Brasher et al. 2006).

A recent survey on the island of Tutuila in American Samoa, where development has been much less intense than in the Hawaiian islands, showed that sites characterized by human activity (including substantial amounts of trash, elimination of riparian vegetation, nutrients and contaminants from household graywater, and raw sewage from piggeries) have species composition, richness, and abundance that is similar to non-impacted sites (Wade et al. 2008). While these more rural development impacts have not yet negatively impacted stream communities in American Samoa, increasing human populations have resulted in road building and the associated dredging, channelization and retaining walls, which are causing extensive habitat destruction that may pose a serious threat to stream quality (Wade et al. 2008).

Channelization

Studies in Hawaii, and on the island of Oahu in particular where development has been substantial, provide an indication of the habitat alteration that is beginning to occur across the Pacific as other islands also begin to develop rapidly. Associated with population growth and urbanization is an increase in the number of road crossings over streams, the flood control projects being implemented, and channels realigned around housing projects (Brasher 2003; Resh 2005). Channel modifications involve clearing riparian vegetation, realigning channels, and reinforcing the altered banks, thereby creating straightened, concrete-lined channels (Hathaway 1978; Norton et al. 1978). Channel modification is severe in the state of Hawaii where almost 20% of the streams are channelized (Hawaii Stream Assessment 1990). Even more than 30 years ago, 60% of the streams on the island of Oahu were channelized (Timbol and Maciolek 1978). The result has been fragmentation of stream habitat through degradation of instream and riparian areas (Brasher 2003, Brasher et al. 2004).

Artificially straightened reaches with concrete-lined flat-bottomed channels and reinforced banks are common in the urban areas of Oahu. Such modifications are often accompanied by removal of riparian vegetative cover, and a reduction in substrate complexity (removal of large boulders). The end result is a wide, shallow, unshaded, and generally homogenous stream reach; a stark contrast to the steep, heavily vegetated, boulder strewn reaches typical of the more pristine streams in forested areas of Hawaii (Brasher et al. 2004). These conditions, along with a proliferation of non-native fishes and crustaceans, have led to a decline in native freshwater macrofauna on Oahu (Kinzie 1990). A recent study on Oahu showed that streams with the highest degree of urbanization contain the fewest native fish larvae (Luton et al. 2005).

Sedimentation

In island settings, siltation levels are typically higher at stream mouths than farther upstream, reflecting a natural elevation gradient (Brasher et al. 2006). Developed sites have also been shown to have substantially higher levels of siltation and embeddedness and much smaller substrate than undeveloped sites due to anthropogenic activities of channelization and removal of larger rocks, thus magnifying the natural elevation gradient (Brasher et al. 2004). This creates habitat more suitable for introduced species such as poeciliids (McRae 2001) than for native species such as *S. stimpsoni* which, as a primarily benthic algal feeder requires substrate clear of silt.

Deforestation in Fiji is another example from a Pacific island where development has resulted in significant sediment loads being transported to a stream system. Insect diversity was shown to be significantly lower in a stream with elevated loads of sediment due to logging, when compared to a stream in a watershed where no logging had occurred (Haynes 1999). After logging, species with patchy or sparse populations were slow to return, leading to the suggestion that a long-term effect of sedimentation due to logging may be the extinction of some freshwater invertebrate species (Haynes 1999).

Riparian Cover and Temperature

The increased width and decreased depth associated with channelization can also cause excessive solar heating (Timbol and Maciolek 1978; Shier 1998). Channelized urban streams on Oahu typically have higher daily mean and maximum water temperatures, and greater diel fluctuations in water temperature than streams in more pristine forested areas of Hawaii (Brasher et al. 2004). Additionally, in these urban streams increased solar radiation and elevated water temperature promote excessive algal growth, which in turn results in strong diel fluctuations in pH and dissolved oxygen (Norton et al. 1978). Water temperatures in sections of streams in low-elevation urbanized areas with sparse riparian canopy cover can reach above 30° C (Brasher et al. 2004), which can be lethal to native species (Hathaway 1978). However, introduced species with high temperature tolerance such as the convict cichlid *A. nigrofasciatus* can thrive in these areas (Brasher et al. 2006).

Contaminants

Urban and agricultural land uses are often associated with a variety of organochlorine, organophosphate, trace element, and metal contaminants. These constituents are applied on land as pesticides, herbicides, or fertilizers, or may have industrial uses. They are transported to the water through industrial and municipal effluents, soil erosion, and other nonpoint-source runoff, where they can have substantial negative impacts on stream biota (Nowell et al.1999; Oki and Brasher 2003; Cain et al. 2004; Brasher and Wolff 2004; Brasher and Wolff 2007). While the bulk of the research on contaminants in watersheds comes from the Hawaiian Islands, recent work in American Samoa and Guam indicate that similar contaminants issues occur in those islands. In addition, it can be expected that on all Pacific islands with urban and agriculture land use, similar contamination of streams will exist.

Many metals (e.g. arsenic, copper, lead, mercury, and zinc) that occur naturally in the environment are toxic to aquatic biota at high concentrations (Hare 1992; Cain et al. 2004). A recent study of an urban stream on the island of Oahu showed elevated concentrations of lead, zinc, copper, cobalt, and barium, that are associated with urban activities (such as fossil fuel burning and vehicular exhaust) and arsenic that is associated with agricultural activities (DeCarlo et al. 2004). Arsenic is a common impurity in fertilizer, and this may be the source of arsenic in these areas (Anthony et al. 2004). Concentrations of arsenic measured in the sediment at this site were approximately nine times higher than guidelines for the protection of organisms associated with the sediment (Brasher and Wolff 2007). Leaded gasoline and lead-based paints were phased out in the 1970s, but lead persists in soils and continues to enter Hawaiian streams with sediment in runoff, and occurs at elevated concentrations in urban streams on Oahu (DeCarlo and Anthony

2002; Anthony et al. 2004). Concentrations of metals associated with anthropogenic activities typically exceeded guidelines in developed watersheds while those that naturally occur in Hawaiian rocks and soils (such as chromium, copper, and nickel) were elevated in forested areas as well (DeCarlo et al. 2004; Brasher and Wolff 2007).

Organochlorine pesticides were heavily used from the mid-1940s to the mid-1980s in the United States. The persistence of organochlorine pesticides, their tendency to accumulate in soil, sediment, and biota, and their harmful effects on wildlife resulted in restriction or banning of their use 20 to 30 years ago (Nowell et al.1999). Despite use restrictions, these compounds continue to be detected in sediment and fish samples. Once in the system, these compounds (which have low solubility) are mostly associated with bottom sediments that can be ingested by benthic organisms. These organisms are then eaten by fish and birds, transferring the contaminants to higher trophic levels in aquatic and terrestrial food chains. Studies conducted in urban streams on Oahu from 1970 through 2000 have shown elevated concentrations of organochlorine pesticides in stream sediment and fish (Bevenue et al. 1972; Tanita et al. 1976; Schmitt et al. 1981, 1985, 1990; Hunter et al. 1995; Brasher and Wolff 2004).

In addition to direct impacts on stream fauna, contaminants can be transported from the stream to near shore areas. Recent studies in Saipan (summarized in Denton et al. 2001, 2008) reported numerous metal and organic compounds at elevated concentrations in the marine sediments and marine organisms near the vicinity of the Puerto Rico dump (landfill).

Stream Flow Alteration

Recent studies in Hawaii clearly indicate that stream flow alteration is a significant threat to native aquatic communities (Kido 1996; Brasher 1997a; Way et al. 1998; McIntosh et al. 2002; Kinzie et al. 2006). Stream flow can be reduced by pumping groundwater from wells or by directly diverting surface water (Oki and Brasher 2003). Results can range from a slight reduction in discharge to complete drying of sections of the stream. In addition to the direct impacts of reduced velocities and depths caused by water diversions, the reduced stream flow in areas where streams have also been channelized can result in higher water temperatures and decreased levels of dissolved oxygen (Timbol and Maciolek 1978; Brasher et al. 2004; Kinzie et al. 2006). Furthermore, sublethal or indirect impacts, including competition, predation, behavioral changes, changes in life history characteristics, and alterations of food chains, can all potentially result from stream flow alterations (Brasher 1997a; McIntosh et al. 2002; Larned et al. 2003).

Even in relatively pristine watersheds not yet affected directly by modern urban development, stream diversions can result in reduced flow velocity and water depth, thereby changing habitat conditions and potentially reducing habitat availability for native fish (Brasher 1997b, 2003; McIntosh et al. 2002; Kinzie et al. 2006). Channel width, depth, and water velocity can be reduced by water diversion; this reduction in habitat availability is then reflected in lower densities of native fish and higher overlap in habitat use among species in the diverted stream (Brasher 1997b). In addition, fewer fish and snails may be present in sampling areas above the water diversions, presumably because of the difficulty in traversing the periodically dry reach just downstream of the diversions (Brasher 1996, 1997b, 1997c).

Modifications of stream ecosystems are typically most intensive at the lower elevations, which may have the greatest impact on the migrations of seaward-moving larvae and returning juveniles (Kinzie and Ford 1982; Kinzie 1990; Resh et al. 1992; Pringle 1997; Pringle and Ramirez 1998; Benstead et al. 1999; March et al. 2003). The larvae may be entrained (captured) by diversion weirs and ditch systems as they wash downstream, and both downstream larval dispersal and upstream juvenile migration is impeded by dry or low-flow stream reaches that result from water diversion (Kinzie 1988; Resh et al. 1992; McDowall 1995; Brasher 1996, 1997a; Pringle 1997; Way et al. 1998; Benstead et al. 1999; Fievet 2000; Fievet et al. 2001; Luton et al. 2005). This was demonstrated in a stream on Kauai where abundance and biomass of drifting invertebrates was highest just above the dam and lowest just below the dam, suggesting that most of the drifting invertebrates were entrained into the diversion ditch (Kinzie et al. 2006).

Invasive Species

Development can cause changes to stream habitat that result in lower habitat heterogeneity and increased abiotic variability, creating an environment more suitable for some introduced species than for the native fauna that evolved in these systems (Brasher et al. 2006). Introduced generalist species are typically better adapted than native species to degraded habitats and once established in these habitats, they can cause further reduction in native populations directly and indirectly through competition, predation, and the introduction of parasites and diseases (Font and Tate 1994, Brown et al. 1999, Brasher 2003; Font 2003; Larned et al. 2003; Brasher et al. 2006).

Hawaii’s extreme isolation has made it especially susceptible to invasive species because the native flora and fauna evolved with minimal exposure to the biotic forces of competition and predation, and are consequently unable to compete with invasive introduced species (Loope et al. 2001; Staples and Cowie 2001). In addition, predation on postlarvae of the native fish by introduced species may be substantial as the postlarvae attempt to migrate through altered habitat to the upstream reaches of streams or attempt to settle in the lower reaches (Brown et al. 1999; March et al. 2003).

The native stream fauna of Samoa, Hawaii, and Guam is well adapted to the flashy nature of the tropical streams and the steep topography of the watersheds. All of the native gobies have fused pelvic fins, allowing them to cling to the substrate during torrential flows and to climb steep waterfalls (Ford and Kinzie 1982; Kinzie 1990). While the native species are adapted to the natural flashy hydrologic conditions in unaltered streams, the established introduced species are typically adapted to more lentic habitats and may be unable to withstand higher velocities and flows, thus limiting their distribution to the more disturbed systems (Brown et al. 1999, McRae 2001, Brasher et al. 2006). With increasing development, the habitat features required by native species are disappearing, and streams are becoming more suitable for generalist introduced species which are typically better adapted for altered habitats than native species (Maciolek 1977; Norton et al. 1978; Brown et al. 1999; Brasher et al. 2006). Introduced species are most common in the more developed stream reaches, reflecting their higher tolerance for altered habitat conditions including elevated water temperatures, slower water velocities, and increased levels of siltation and embeddedness (Brasher et al. 2006). For example, a recent survey on Tutuila in American Samoa found introduced poeciliids only in the terminal reaches of three disturbed streams (Wade et al. 2008).

Surveys conducted on Oahu in the late 1970s showed that introduced fishes and crustaceans formed 87 percent of the fauna in altered streams and that native species were absent from cement-lined channels (Norton et al. 1978; Timbol and Maciolek 1978). Today more than 50 species of introduced fish, invertebrates, reptiles, amphibians, and aquatic plants are established in streams and reservoirs in Hawaii (Maciolek 1984; Eldredge 1992; Brown et al. 1999; Yamamoto and Tagawa 2000; Staples and Cowie 2001), with the number of introduced species in Hawaiian streams much larger than the number of native species (Devick 1991). For mollusks alone, 22 freshwater snails and slugs have been introduced to the Hawaiian Islands (Cowie 1997), and 12 are known to be established (Cowie 1998). In contrast to most of the native species with distinct and limited reproductive seasons (Kinzie 1993, Ha and Kinzie 1996), many of the introduced species can reproduce throughout the year in the tropics, even if they are seasonally constrained where they originated (Kondratieff et al. 1997; Yamamoto and Tagawa 2000; Brasher et al. 2006) and are prolific breeders that reproduce large numbers very rapidly (Yamamoto and Tagawa 2000), allowing them to reach very high densities.

In a recent study on three Hawaiian islands—Hawaii, Kauai, and Oahu—introduced species dominated the samples (Brasher et al. 2006). Of the 28 fish and crustacean species that were collected during the study, nearly two-thirds (19 species) were introduced. The Tahitian prawn *M. lar,* which was introduced to Hawaii in 1956 and eventually spread to streams throughout the state as a result of its amphidromous life cycle (Yamamoto and Tagawa 2000), was present in the largest number of streams (71%) sampled. The introduced atyid shrimp (the grass shrimp *N. denticulata*), which does not have an oceanic larval life stage and so cannot move between stream systems without human intervention, had the highest abundance (46% of the individuals collected during the study) on the islands it currently occurs.

The impact of introduced species on aquatic ecosystems ranges from relatively benign to highly detrimental. Not only are the introduced species well suited for disturbed habitat conditions, some actually create such conditions. For example, introduced catfish and crayfish dig holes in stream banks, causing erosion and increasing water turbidity (Yamamoto and Tagawa 2000). Other species, such as smallmouth bass, introduced as a sport fish, are voracious predators that feed on native fish and shrimp (Yamamoto and Tagawa 2000). Many aquarium pets, such as the cichlids, are also very aggressive and predatory. In addition to whatever competition and predation they exert directly on native fishes in altered streams, introduced species can also serve as a source of introduced parasites, which then infest the native fish species (Bunkley-Williams and Williams 1994; Font and Tate 1994; Font 2003).

Measurable Objectives

Vital Signs are physical, chemical, and biological elements and processes of ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values. Early detection of potential problems allows park managers to take steps to restore ecological conditions of park resources before serious damage occurs.

Responses to natural drivers and anthropogenic stressors can be evaluated at four spatial scales: the individual (organism), population, community, and ecosystem (Figure 1.5). Individual organisms will show physiological responses (e.g., oxygen consumption, feeding rates), morphological responses (e.g., anatomical deformities, growth rates), and behavioral responses (e.g., migration, prey vulnerability) to both natural drivers and anthropogenic stressors. At the population level, abundance, distribution, and age structure may be affected. At the community level, there may be shifts in species diversity and abundance and functional roles. At the ecosystem level, alterations in food webs, nutrient dynamics, and spatial structure may occur.

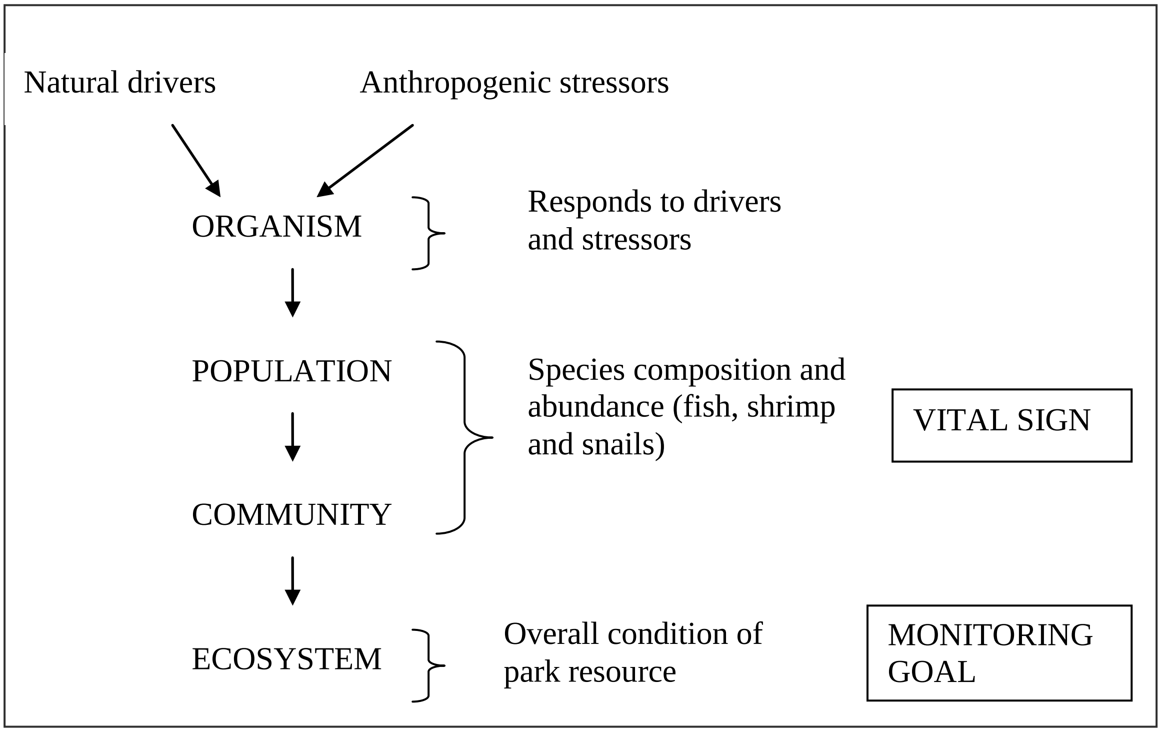

Figure 1.5. Responses to natural and anthropogenic stressors.

The PACN has selected freshwater communities as a Vital Sign that can serve as an indicator of watershed quality. With numerous potential threats to watersheds as well as the streams themselves, monitoring the status of stream systems is a high priority.

The monitoring questions for this protocol are:

1. What are long-term trends in spatial distribution and abundance of freshwater fish and invertebrates (including snails and crustaceans)?

2. How do changes in habitat characteristics affect the composition, distribution, and abundance of freshwater fish and invertebrates?

The measurable sampling objectives (Objective I) are described as three components:

Objective Ia: Determine long-term trends in the spatial distribution and abundance of **native** fish and invertebrates (shrimps and snails) in selected streams.

Objective Ib: Determine long-term trends in the spatial distribution and abundance of **introduced** fish and invertebrates (shrimps and snails) in selected streams.

Objective Ic: Determine long-term trends in habitat characteristics in selected streams.

The management objective (Objective II) provides a link between habitat characteristics (that can potentially be affected by management activities) and biotic characteristics:

Objective II: Improve understanding of associations between stream animal communities (fish and invertebrates) and their habitat by examining the associations among physical/chemical habitat characteristics and spatial distribution and abundance of animal communities in different streams or with changes in habitat (natural and anthropogenic) over time.

The primary monitoring goals are to provide information on the spatial distribution and abundance of key fauna (fish, shrimp, and snails), and to measure habitat characteristics associated with these fauna. This will provide the necessary information to assess natural variation in distribution and abundance over time, as well as population responses to human activities that alter habitat characteristics.

Management Implications

The data collected following this monitoring protocol will provide park managers with information on the long-term status and trends of aquatic resources relative to natural processes and anthropogenic stressors, and will serve as a tool to evaluate the effectiveness of management actions aimed at protecting or restoring aquatic ecosystems. The monitoring questions are designed to address management concerns. Specifically, what is the status of the stream fauna? At what point does a manager need to take action? For example, the presence of any new introduced fauna would serve as a trigger. Likewise, under the current statistical design, a decline for two consecutive years of 50% of the population (which is outside of the estimated natural variation of approximately 30% from year to year based on preliminary analyses) would serve as a trigger. After five years of monitoring there should be sufficient information to begin determining thresholds and trigger points for each stream system. The collection of physical habitat data and co-location with water quality sampling will provide a link between management activities (that can influence habitat characteristics) and the spatial distribution and abundance of the stream fauna.

Parks and Streams Where Protocol Will Be Implemented

Stream sampling will be implemented in selected perennial streams in four parks: the National Park of American Samoa (NPSA) on the islands of Tau and Tutuila, War in the Pacific National Historical Park (WAPA) on the island of Guam, Haleakala National Park (HALE) on the Hawaiian island of Maui, and Kalaupapa National Historical Park (KALA) on the Hawaiian island of Molokai (Figure 1.6). Four streams will be sampled at NPSA: three on Tutuila (Fagatuitui in the village of Fagasa, Leafu in the village of Vatia, and Amalau in the village of Amalau) and one on Tau (Laufuti). The streams on Tutuila were selected to represent a forested site (Fagatuitui), an urbanized site (Leafu), and a rural site where an invasive plant removal and native forest restoration project is occurring (Amalau). Laufuti is the only perennial stream in the park on Tau. One stream will be sampled at WAPA: Asan. This is the only perennial stream at

WAPA. Two streams will be sampled at HALE: Palikea (which consists of Palikea and the tributary Pipiwai, which together flow in to Oheo Gulch) and Alalele. One stream will be sampled at KALA: Waikolu. These are the only perennial streams in HALE and KALA.

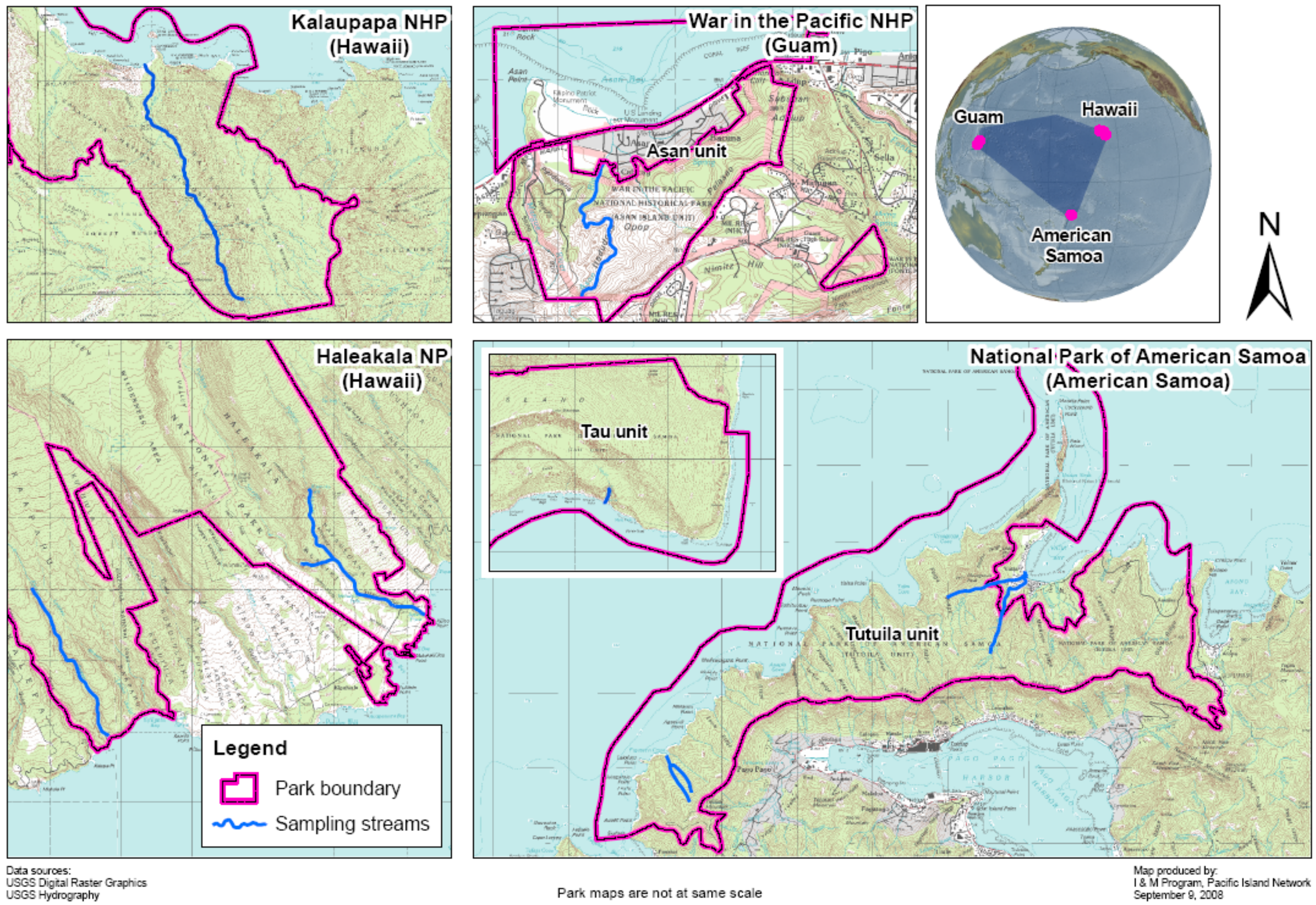

Figure 1.6. Location of sampling streams at each of the four parks.

Chapter 2: Sampling Design

Background

The purpose of this chapter is to describe the factors considered in selecting the sampling design, sampling frame, methods for site selection and co-location, biotic and habitat components to be monitored, and frequency of monitoring. Based on discussions with NPS and USGS scientists, PACN staff, and bio-statisticians, the sampling design for the stream monitoring protocol will consist of a combination of permanent (fixed) sampling station locations and random station locations that are newly selected each year. The sampling stations in each stream will be sampled annually.

The primary monitoring goals are to collect information on the spatial distribution and abundance of key fauna (fish, shrimp, and snails), and to measure habitat characteristics associated with these fauna. This will provide the necessary information to assess natural variation in abundance and habitat characteristics over time, as well as population responses to human activities (such as water diversion). In addition, these surveys will address management objectives of understanding how species distribution and abundance vary with habitat characteristics and how changes in species composition, distribution, and abundance correspond with changes in habitat (natural and anthropogenic) over time.

A number of methods have been used to survey stream fauna in American Samoa, Guam, and Hawaii. The three most common strategies are snorkeling (quadrat, line, and reach methods), electrofishing, and trapping/netting. Each of these methods may be used in one or more streams in the PACN, depending on logistical considerations and ongoing or past survey activities in a given stream.

Target taxa for this protocol are fish, shrimp, and snails. Other potential taxa that could be monitored include benthic macroinvertebrates (such as insects) and algae. The target taxa were selected based on time and fiscal constraints, but others could be added in the future. Baseline data on fish, shrimp, and snails are already available for the streams in the Hawaiian parks; HALE (Palikea and Alelele) and KALA (Waikolu). This focus is also compatible with work being done in Guam and American Samoa. The major federal stream assessments, NAWQA and EMAP, include algae and macroinvertebrates as part of their surveys.

Important Considerations

One of the Inventory and Monitoring program's goals is the ability to statistically detect trends over time. Consequently study design and site selection are based upon statistical considerations that influence replication, namely number and spatial distribution of sampling locations. These are discussed in detail in this chapter. In addition to statistical concerns, a number of practical, logistical, and fiscal constraints also have influenced the final design of the Pacific Islands Stream Monitoring: Fish, Shrimp, Snails and Habitat Characterization protocol.

Maximizing Personnel Safety

Conducting monitoring work in the aquatic environment presents special challenges and hazards. The safety of field personnel during each site visit is a critical consideration. For example, sampling in narrow steep canyons during and immediately following rain events can be particularly hazardous. During and after rain, which may be located far up the watershed, there is always the risk of flooding. Flooding creates multiple hazards including strong currents, rapidly moving objects, and the elimination of safe escape routes, all of which can lead to serious physical harm or even death. Additionally, because the rocks are often covered with algae, hiking in streams presents the possibility of slipping, which can lead to serious physical injury. In the event of a mishap, it is important to have at least three field crew members, so that one can stay with the injured person, and the other can go for help. At a minimum, all field crew should be certified in CPR and first aid. In addition, training in wilderness first aid and swift water rescue is recommended because much of the fieldwork will occur in remote areas. Additional details regarding safety are included in SOP #1: "Safety Protocol."

Logistical and Fiscal Constraints

Field activities such as site selection and sampling events are constrained by personnel and equipment availability, site location, topography, and weather. Thus, each park has a limited window of time when field activities can be conducted, restricting the number of sites that can be completed within the sampling design. The two largest logistical constraints for the stream protocol are the extensive travel required to reach a given stream, and the limited window of time when field activities can be safely conducted (during the dry season).

Ultimately, the implementation of this protocol will strongly be influenced by fiscal considerations. Fiscal constraints within this program will affect staffing levels, frequency of sampling, and the number of monitoring locations that can be visited.

The recommended sampling frame (sample each stream one time per year, each year) is presented as the template. This design is feasible given current budget allocations. As the highest cost is simply getting to a site, reducing costs would be most effective by reducing the number of streams (parks) visited each year rather than reducing sampling activity within a given stream (park) on a single trip.

Integration with Other Vital Signs

To enhance the value of the datasets collected, the stream protocol was designed to be integrated with the PACN water quality vital sign protocol. Co-locating and co-visiting during identical sampling periods lends greater correlative power among the environmental variables (physical and chemical habitat conditions) and the stream biota. In addition, integrating the water quality and stream protocols provides an economic benefit, by reducing travel costs (which can be a substantial percentage of the total sampling costs).

Sampling

Stream Selection

This protocol is designed for monitoring the larger perennial streams in each park. Smaller and intermittent streams are not included, but the SOPs could be modified to include such streams if requested by park management. Four streams will be sampled at NPSA: three on Tutuila (Fagatuitui in the village of Fagasa, Leafu in the village of Vatia, and Amalau in the village of Amalau) and one on Tau (Laufuti). The streams on Tutuila were selected to represent a forested site (Fagatuitui), an urbanized site (Leafu), and a rural site where an invasive plant removal and native forest restoration project is occurring (Amalau). Laufuti is the only perennial stream in the park on Tau. One stream will be sampled at WAPA: Asan. This is the only perennial stream at WAPA. Two streams will be sampled at HALE: Palikea (which consists of Palikea and the tributary Pipiwai, which together flow in to Oheo Gulch) and Alelele. One stream will be sampled at KALA: Waikolu. These are the only perennial streams in HALE and KALA.

Station Selection

The location of both permanent fixed sites and variable (rotating) stations will be selected randomly. If a generated random location has been selected previously for a fixed station then an alternative random location will be selected. In instances where stations have already been either surveyed or monitored (Alelele, Palikea, and Waikolu), a subset of the established sites will be randomly selected as permanent fixed stations for this protocol. The original stations were all selected randomly.

Sampling Units

The fundamental sampling unit for PACN stream biota monitoring is a sampling station. A sampling station is defined as a randomly chosen 30-meter reach in the stream. Some stations will be fixed (permanent) and some will be variable (new each year). Multiple sampling stations will be located along each stream. The number of stations within a stream will vary (Table 2.1) by stream. Currently there are no variable (rotating) stations in American Samoa, this may change over time. Inference from the data collected following this protocol is to the stream in which the stations are located. Each station will be divided in to quadrats or segments for biota sampling, depending on the stream location and the target biota (described in the SOPs for each sampling component).

Table 2.1. Number of fixed and rotating stations per stream with current sampling strategy.

Park	Stream	Fixed	Rotating
NPSA	Laufuti	4	na
	Leafu	3	na
	Fagatuitui	3	na
	Amalau	2	na
WAPA	Asan	8	8
HALE	Palikea	6	7
	Alelele	2	1
KALA	Waikolu	8	8

Target Population

The target populations for this protocol are the fish, shrimp, and snails in selected perennial freshwater stream reaches. The longitudinal distributions of fish, shrimp, and snails are limited by the presence of cliffs or waterfalls and the variable climbing ability among different species. Sampling will occur from the mouth to the known upper limits of the taxa within PACN park boundaries. Inference from this sampling will be to fish, shrimp, and snail populations within a given stream.

Rationale for Sampling Design

Several different spatial and temporal sampling designs were considered for this protocol. Spatial designs included simple random sample, systematic sample (grid), stratified random sample, cluster sample, and Generalized Random Tessellation Stratified (GRTS) (DeBacker et al. 2005). Each of these spatial designs has advantages and disadvantages. The stream monitoring protocol is based on the simple random sample for the following reasons:

1. This is the simplest strategy to set up and implement within a Geographic Information System (GIS).

2. This strategy ensures that every portion of the sampling frame has an equal probability of being selected. Some of the PACN parks have abundance population parameters that are relatively unknown; therefore it would be difficult to stratify or cluster sampling units based on known habitats, geomorphological structures, or organism distribution patterns.

3. The GRTS system, while appealing, is complicated to implement without trained statisticians (DeBacker et al. 2005).

Temporal designs considered in this protocol included sites always revisited, sites never revisited, rotating panels with sites sampled on 3 consecutive occasions, and split panels which partition sites into two or more revisit designs (McDonald 2003). The split panel sampling strategy will give the PACN both status and trends, spatially and temporally.
The PACN stream protocol uses a split-panel design for the following reasons:

1. A split panel sampling design allows for increased spatial sampling while simultaneously examining multiple temporal scales and permitting broader ecological and statistical

inference beyond that provided by fixed or permanent sampling locations alone (Skalski 2005).

2. The split-panel design maximizes spatial replication while reducing the within-site effort, using a combination of fixed and rotating panels to maximize power.

3. Sampling a new set of sites annually minimizes the bias in estimates of status and continually updates prior estimates through time series calculations (Skalski 1990).

4. Leaving fixed sites within the design is useful for several reasons. First, the majority of the historical data uses fixed sampling locations so spatial comparisons will be simpler. Second, after the initial random setup, the fixed transects should be easier to resample, thus reducing preparation time and ultimately costs to generate the random grid for subsequent transect measurements (Green and Smith 1997). Third, utilizing exclusively randomized sampling without fixed sites makes it difficult to detect change if it occurs dramatically over time: random design measures inherent spatial variation at each sampling period, which adds variance associated with spatial heterogeneity rather than changes or patterns that are time-related (Green and Smith 1997). Fourth, fixed sites can provide additional information in variance structure that is difficult to obtain with random transects (Connell et al. 1997).

Establishing Sampling Stations (Spatial Design)

Sufficient spatial coverage throughout each stream is needed to provide broad inference beyond the exact sampling locations. Sampling stations will be located from the mouth to the upper distribution limits of the biota. The spatial coverage outlined in this design should be sufficient to make inferences to the entire target population within the sampling frame, in other words, inference to the entire stream.

To determine the location of the sampling units for monitoring, spatial coordinates for potential sampling stations will be randomly generated. Fixed sampling stations in HALE and KALE will be located at sites from which is there is already monitoring data, to lend to the interpretation of trend data. Although fixed for this protocol, these sites were randomly chosen in the original studies. The initial random selection regime for these sites fits the sampling methods of this protocol, allowing data to be compared among previously established fixed sites and newly established fixed sites. Both fixed and rotating sites in other parks will be selected randomly. Randomly selected alternative locations will also be generated in case the initial locations are unsuitable with respect to safety, accessibility, or resource availability (for example, presence of water).

Full details regarding locating and documenting site locations can be found in SOP # 3: “Locating Sampling Stations,” Appendix #5: “Logistics,” Appendix #7: “Sampling Sites (Maps and Coordinates),” and in a brief narrative provided below. When all sites are selected, they should be sampled in an order that minimizes travel time and prevents disturbance of other sampling locations. Before starting field work, the site coordinates and station ID numbers should be entered into a Global Positioning System (GPS) (SOP #4: “Using GARMIN Global Positioning System (GPS) Units”; Also see SOP #5: “Downloading and Uploading Data Between Garmin GPS and ArcGIS” and SOP #6: Using the Ricoh GPS Camera”).

Temporal Design and Sampling Frequency

The sample timing for each park is based primarily on environmental conditions. Sampling needs to occur during base flow for safety, ecological (behavioral changes during higher flows), and logistical (snorkeling needs to be done in clear water) reasons. To minimize delays due to stream flooding, sampling should occur during the dry season. Stream sampling will also be scheduled to coincide with the water quality protocol sampling.

Sampling all possible sites would greatly increase the breadth of ecological and statistical inference that could be achieved, but would be prohibitively expensive and limit the temporal scale at which repeat sampling could be done, increasing the length of time to detect any trend. Because of the inherent variability of the data, increased time (i.e. sampling every other year) between samples greatly increases the time required to detect potential issues. Given these considerations, targeted (random) stations within each stream will be sampled once per year, during the designated sampling window. Sampling windows are based on two criteria: (1) sampling should occur during the same season each year, and (2) weather conditions. The currently recommended level of replication will be evaluated as data are collected in the 3-5 years following implementation of the monitoring program, and modified as needed.

The current sampling design is based on consideration of safety issues, logistical limitations, financial constraints, analyses of previously collected data sets, and consultation with statisticians and experienced aquatic ecologists. The design for this monitoring plan has been developed with the best available data, but modifications within an adaptive sampling design framework will be necessary as implementation proceeds. It is critical to this monitoring program that the data be collected and analyzed annually, and that the results be used to adaptively "fine tune" the design to optimize effort, statistical power, and inference.

Sampling Methodology

Faunal survey methods (described in detail in the SOPs) are based on established methods currently used by state, territory, and federal agencies for their stream monitoring programs, or methods already being used in a given park (the selected methods are described in Chapter 3). Habitat characterization (described in detail in the SOPs) is based on established EPA EMAP (Peck et al. 2006) and USGS NAWQA (Fitzpatrick et al. 1998) protocols, and methods currently being used in other I&M networks (Brasher et al. in press). A complete habitat characterization (using data from 6 transects) will be conducted in Guam, to be consistent with ongoing sampling activities by the Guam DEQ, and because the stream is located in an urbanizing watershed. Rapid habitat assessments will be conducted in all other parks, and are a modified version of the complete characterization method. In the event of changes in land use (from forested to developed, or changes in water withdrawal activities, for example) in any of the other parks, a switch to the complete habitat characterization would be appropriate prior to any land use changes. Habitat sampling is further described in Chapter 3, and complete details are provided in the SOPs.

Statistical Evaluation of Existing Data Sets

Preliminary analyses for sample design and sample size estimation using data collected in Waikolu stream (Brasher, 1996), and in several streams on Maui (Brasher, unpublished data) are presented below. John Skalski (Skalski, 2005) utilized this data for estimation of variance components between streams, between stations, and between quadrats, by year and by stream. Power analyses and precision estimates are also discussed in this chapter, to provide preliminary information on the number of stations and number of quadrats to be sampled per stream. As the monitoring program continues, data will become available to refine these calculations for Waikolu and to conduct these analyses for the other streams in other parks. Additional preliminary analyses can be found in Appendix #6: "Additional Statistical Analyses and Power Estimates for Preliminary Samples Size Determination."

Annual Precision Calculations

Precision in estimating variables (e.g. species abundance) is affected by spatial, temporal, and human sources of variation, including identification and counting. Increasing precision is possible by increasing replication within the largest component of variation. Precision is affected by three levels of source variability:

1) at the level of the stream - Coefficient of Variation$_1$ (CV_{STR})
2) at the level of the sampling station - Coefficient of Variation$_2$ (CV_{STA})
3) at the level of the quadrat - Coefficient of Variation$_3$ (CV_{QUAD}).

To determine the precision of the estimate, it is first necessary to quantify the existing estimates of expected variation.

Existing estimates of expected variation

Begin by estimating variance components associated with

1) stream variance $\left(\sigma^2_{STR}\right)$;

2) station variance within a stream $\left(\sigma^2_{STA}\right)$;

3) quadrat variance within a station $\left(\sigma^2_{QUAD}\right)$.

This relatively simple calculation by year and season showed variance estimates changed considerably over time (Appendix #6: "Additional Statistical Analyses and Power Estimates for Preliminary Samples Size Determination"). However, when coefficients of variation (CV) were calculated, the estimates were more numerically stable. The CV for streams was calculated using

$$\mathrm{CV}_{STR} = \frac{\sqrt{\hat{\sigma}^2_{STR}}}{\overline{\overline{\overline{x}}}} \qquad (2.1)$$

where $\overline{\overline{\overline{x}}}$ is the grand average calculated across streams. The same equation can be used to calculate the CV for stations or quadrats, using the variance and grand average data for stations and quadrants respectively (Table 2.2).

Table 2.2. Coefficients of variation (CVs) for streams (CVSTR), stations (CVSTA), and quadrats (CVQUAD) by fish species and island.

Island	Species	CV_{STR}	CV_{STA}	CV_{QUAD}
Maui	*A. guamensis*	0.24	0.44	1.57
	L. concolor	0.79	0.92	1.24
	S. stimpsoni	1.29	0.82	1.27
Molokai	*A. guamensis*	0.67	0.92	2.28
	L. concolor	0.15	0.47	0.81
	S. stimpsoni	0.21	0.74	0.83

Once the CVs are known, it is possible to then calculate the precision of the estimates.

Precision Calculations

Precision can be defined in terms of relative error (ε),

$$P\left(\left|\frac{\overline{x}-\mu}{\mu}\right| < \varepsilon\right) = 1-\alpha\,. \tag{2.2}$$

This implies that the design of this monitoring strategy will have an inherent quantifiable relative error in estimation, and the parameters driving that estimation can be set to programmatically acceptable limits. For example, to estimate the population status within $\pm 10\%$ of the true value 90% of the time set ε = 0.10, $1-\alpha$ = 0.90, to get

$$P\left(\left|\frac{\overline{x}-\mu}{\mu}\right| < 0.10\right) = 0.90\,,$$

The ultimate choice of ε and $1-\alpha$ is at the discretion of the program or project manager; however, this monitoring strategy design is based on estimating the population status within $\pm 10\%$ of the true value 90% of the time.

Solving equation (2.2) for ε, then rewriting in the form of variance, we get

$$\varepsilon \approx Z_{1-\frac{\alpha}{2}} \frac{\sqrt{\operatorname{Var}(\overline{x})}}{\overline{x}}\,. \tag{2.3}$$

where $Z_{1-\frac{\alpha}{2}}$ = standard normal deviation value corresponding to $P\left(|Z| < Z_{1-\frac{\alpha}{2}}\right) = 1-\alpha$.

Expanding to our anticipated error levels in sampling data collection, we get equation (2.3) expressed as

$$\varepsilon \approx Z_{1-\frac{\alpha}{2}} \sqrt{\frac{(1-f_1)\mathrm{CV}_{STR}^2}{n} + \frac{(1-f_2)\mathrm{CV}_{STA}^2}{nm} + \frac{(1-f_3)\mathrm{CV}_{QUAD}^2}{nmk}}\,, \tag{2.4}$$

where

n = number of streams sampled

f_1 = fraction of streams within the sampling frame sampled (i.e., n/N)

m = number of stations sampled per stream

f_2 = fraction of possible stations within a stream sampled (i.e., m/M)

k = number of quadrats within a station sampled

f_3 = fraction of possible quadrats within a station sampled (i.e., k/K)

Substituting the results of Table 2.2 with equation (2.4) we calculate the anticipated precision for the relative error estimate of each species' population estimate based on the sampling parameters

For example, looking at *S. stimpsoni* in Waikolu stream on Molokai, we see

$$\varepsilon = Z_{1-\frac{\alpha}{2}}\sqrt{\frac{(1-f_1)(0.21)^2}{n}+\frac{(1-f_2)(0.74)^2}{nm}+\frac{(1-f_3)(0.83)^2}{nmk}}.$$

This data was collected from one stream with 23 thirty-meter stations using 10 one-meter quadrats per station along the 3,000 meter stream. Again, substituting these values for our n, m, and k values as well as using our 90% confidence interval, we get

$$n = 1$$
$$m = 23$$
$$k = 10$$
$$1-\alpha = 0.90 \rightarrow Z_{1-\frac{\alpha}{2}} = 1.645.$$

Substituting these values into the equation gives us

$$\varepsilon = 1.645\sqrt{\frac{(1-f_1)(0.21)^2}{1}+\frac{(1-f_2)(0.74)^2}{1(23)}+\frac{(1-f_3)(0.83)^2}{1(23)(10)}}.$$

Next, we consider the sampling fractions of the data and get

$f_1 \approx$ 1, meaning there was only one stream and it was sampled;

$f_2 \approx$ 0.23 meaning 23% of the possible stations on the stream were sampled;

$f_3 \approx$ 0.033, meaning that only 3.3 percent of the possible quadrat locations within a station were sampled.

Substituting these values, we get

$$\varepsilon = 1.645\sqrt{\frac{(1\text{-}1)(0.021)^2}{1} + \frac{(1\text{-}0.23)(0.74)^2}{1(23)} + \frac{(1\text{-}0.033)(0.83)^2}{1(23)(10)}}$$

$$\varepsilon = 1.645\sqrt{0 + 0.0183 + 0.0029}$$

$$\varepsilon = 0.2397$$

In other words, this study (which estimated the average *S. stimpsoni* abundance in Waikolu stream) was determined to have a precision of ± 24%, with 90% confidence. The study design for this monitoring protocol will follow similar methods but not be as intensive as the 1993-1994 Molokai study or the 1991-2000 Maui study. Because this monitoring protocol's study design is less intensive than the earlier studies, precision estimates are expected to be slightly less precise. Table 2.3 shows the precision estimates for fish populations by species and island for these two studies.

Equation (2.4) can be used to look at any combination of *n*, *m*, and *k* to determine the desired level of precision. Creating precision analysis graphs provides a visual way to assess the best estimates of target number and length of stations on a stream as well as the number of quadrats for fish population sampling (Figure 2.1).

Table 2.3. Precision estimates for three species of gobies. Estimates use fifteen 30 m stations on a single 3,000 m stream with a 90% confidence interval and the CV data from Table 2.1.

Species	Island	Estimate Value	Precision Estimate
A. guamensis	Maui	0.211	21%
	Molokai	0.401	40%
L. concolor	Maui	0.373	37%
	Molokai	0.194	17%
S. stimpsoni	Maui	0.336	34%
	Molokai	0.297	30%

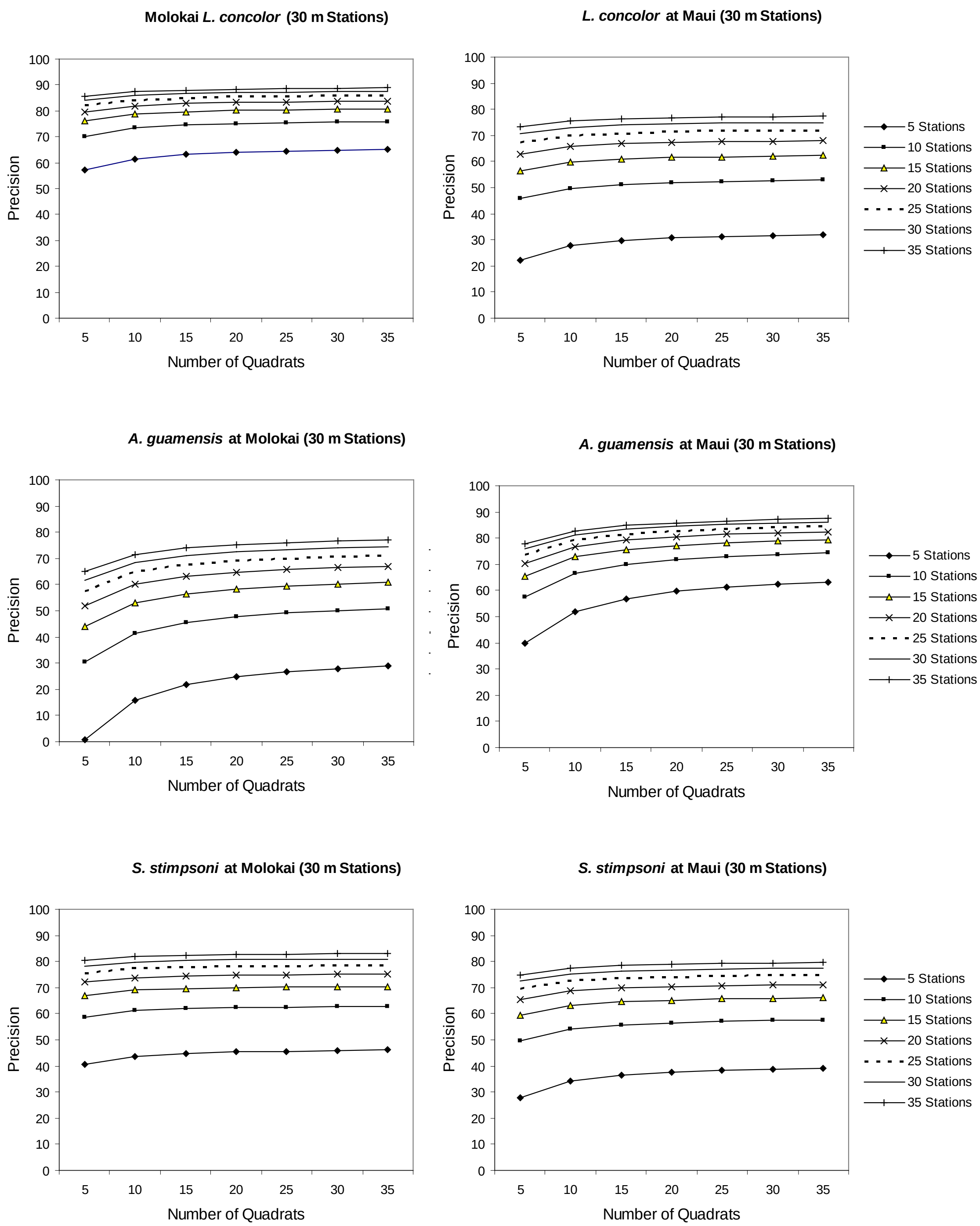

Figure 2.1. Precision analysis curves of 30m length stations on the islands of Maui and Molokai by fish species.

It is apparent from the precision curves that doubling the number of quadrats from k = 5 to k = 10 gives the greatest jump in precision within stations, while increases in precision estimates beyond *k* = 10 yields very little in the way of increase in precision within a station. It is much more effective to increase the station numbers than to increase the number of quadrats within a station, indicating that the greatest variability is between stations and not quadrats. It can also be seen that the benefits gained in precision with increasing station numbers begins to be significantly reduced at 15 stations.

The most efficient use of resources would dictate using the asymptote of the curves, which, based on these precision graphs, give us an annual sample size of 15 stations with 10 quadrats at each station, for Waikolu Stream in KALA. Surveying this sample size in each park should be feasible given current logistical and financial constraints.

Proportion of Fixed Versus Random Panels (Stations)
The purpose of this monitoring effort is to detect change over time with sufficient statistical power to make meaningful statements about the resource status and trends. The split-panel design selected for this protocol maximizes the spatial replication while reducing the within-site effort, using a combination of fixed and rotating panels to maximize power. The optimal proportion of fixed to rotating panels can be estimated from the correlation (r) between years within stations.

The optimal fraction of stations to rotate or replace each year in a panel design depends on the correlation of the annual observations. When the annual correlations (r) are low, the fraction of fixed stations is higher than when the correlations are high. The optimal fraction of stations to retain each year is

$$\text{Proportion of fixed to random stations} = f_{ratio} = \frac{\sqrt{1-r^2}}{1+\sqrt{1-r^2}}. \qquad (2.5)$$

Table 2.4 illustrates the relationship between r^2 and f_{ratio} based on the above equation.

Table 2.4. Optimal fraction of fixed stations in streams to retain from one year to the next in a panel design as a function of interannual correlation.

r^2	f_{ratio}	r^2	f_{ratio}
0	0.50	0.6	0.444
0.1	0.499	0.7	0.417
0.2	0.495	0.8	0.375
0.3	0.488	0.9	0.304
0.4	0.478	0.95	0.238
0.5	0.464	0.99	0.124

For Waikolu stream on Molokai, the temporal correlation between 1993−1994 was calculated for each of the three species. For *L. concolor*, *A. guamensis* and *S. stimpsoni*, there was virtually no correlation from one year to the next (Table 2.5).

For the observed r^2 values in Table 2.4 (0.0866−0.2544), the optimal fixed: random ratio should be approximately 50% for the lowest value. The fixed: random ratio in this protocol is based on the most conservative estimate (the lowest r value). Practical considerations, in particular the cost of working stream stations, suggest this fixed ratio is realistic.

Table 2.5. Average sampling correlations in fish abundance for Waikolu, Molokai (KALA).

Species	r^2	r
A. guamensis	0.0075	0.0866
L. concolor	0.0262	0.1619
S. stimpsoni	0.0647	0.2544

Statistical Power Estimation

When determining the power to detect change over time it is important to consider that there can be inherent and potentially serious statistical analysis issues associated with distributions, (which can be skewed or normal), outliers, cycles (e.g., diurnal, seasonal), missing values, censored data (zero values), and serial correlations (Helsel and Hirsch 2002). Often the most effective methods for parameters that are variable (i.e., uncommon species abundances) and non-normally distributed are non-parametric methods. This protocol measures multiple populations with skewed and truncated distributions and outliers at multiple sites. Therefore, non-parametric methods may be especially useful for trend analyses of this stream monitoring dataset.

In addition, non-parametric methods can be used sooner than parametric methods to determine if there is an increasing or decreasing trend in any monitored parameter. This is because the relative robustness and structural design of non-parametric methods enables them to be relatively insensitive to skewed data and missing values. Therefore, non-parametric methods allow management to be informed of resource trend and alert them to the need of possible action much sooner than parametric methods.

Overall, analysis of data previously collected at Waikolu indicate that 15 stations, 8 of which are fixed and 7 random, with 10 quadrats per station, is the most appropriate sampling design for Waikolu Stream. After 5 years of data have been collected at Waikolu Stream, it will be important to revisit the parametric power to detect change calculations to determine more precisely the actual power to detect change given this sampling design. After 3-5 years of data collection in the other parks, similar calculations can be run to determine the best long-term sampling design for those streams.

Two of the potential methods that can be used for detecting trends are the Sen slope estimator and the seasonal Kendall trend test. These methods can handle missing and non-normal data. While these two methods are similar in approach, the trend slope estimator will give an estimate of the slope of temporal data by comparing every sampling event against every other sampling event, ranking the results, and taking the median as the trend slope estimate. This can be compared with the Kendall trend test which is slightly more sophisticated, taking the differences in all sampling events, replacing values with normalized change indicators (+ slope gets a 1, no slope gets a 0, and – slope gets a -1), computing the year weighted variance for each sampling event, then computing the test statistic for that variance. The result will give a trend with a significance *p*-value (Helsel and Hirsch 2002). Using these two tests is a powerful method of determining if there is a trend (increasing or decreasing) present in biotic data, and whether that trend is significant. However, these tests do not detect specific changes (i.e. 25% decrease in population with 95% confidence over 10 years).

To approach these types of questions, we need to use parametric power estimations. With parametric methods, a specific change can be detected with a specific confidence over a specified timeframe, but parametric methods are much more rigid in their requirements and often take longer and require more samples to get statistically significant results. Despite these additional requirements, parametric statistical methods can be useful when trying to understand variability. When other methods are inconclusive, parametric statistical methods can detect trends in environmental samples and can even help determine necessary sample sizes (National Park Service, Roy Irwin, Biologist, pers. comm., 2008).

Sample size for this protocol is based both on precision of the estimates and on logistical constraints. Even with large replicate data sets, variability is high, yet low variance is essential to achieve high powers to detect change. Working within the current PACN budget to gather the data necessary at precision levels that will be most helpful dictate an estimate of 10 working days with 5 reserve days for inclement weather as the maximum estimated time available for fieldwork at each park. Based on preliminary pilot work, it is realistically possible for a single team of three to sample two sites per day, including hiking up streams with gear to an individual station location.

For this protocol, sample size estimations and power results were determined using two methods: a paired t-test analysis using an online calculator (SS Two samples at *statsalive.com*) recommended by the National Park Service Water Resources Division NPS-WRD (National Park Service, Roy Irwin, Biologist, pers. comm., 2008) and by a sample size independent power calculator created by a statistician hired by the PACN network to consult on statistical sampling designs for monitoring protocols (Skalski 2005). The t-test was good at estimating the sample sizes and power, but lacked the ability to test for a specific change (i.e. β). With the Skalski calculator, variance is the primary driver: if increased sample sizes decrease variance, the power increases but *a priori* knowledge of the change in variance with sample size is not required. Based on the variability associated with annual analyses from previous work, the Skalski methods appeared more appropriate and conservative.

Power curves were created to visually indicate the power to detect change given 15 stations with 10 quadrats per station, and 8 fixed and 7 random sites (Figure 2.2). The results indicate that power to detect change is relatively low for all three species on Molokai: *A. guamensis* 17% - 20%, *L. concolor* 28% - 33%, and *S. stimpsoni* 50% - 59% (Table 2.6). By changing the replicates to 10 fixed and 10 random for each of the species, the power was increased by 3%, 5%, and 9% respectively for *A. guamensis*, *L. concolor*, and *S. stimpsoni*. This protocol cannot recommend more than 20 sites, because this would exceed the number of sites feasible to sample given the current budget and speed with which samples can be collected. Furthermore, the benefit gained by increasing the number of sample sites does not appear to offset the time and fiscal constraints of the program. Nevertheless, Figure 2.2 illustrates the value of increasing sample sizes by showing the corresponding increase in power.

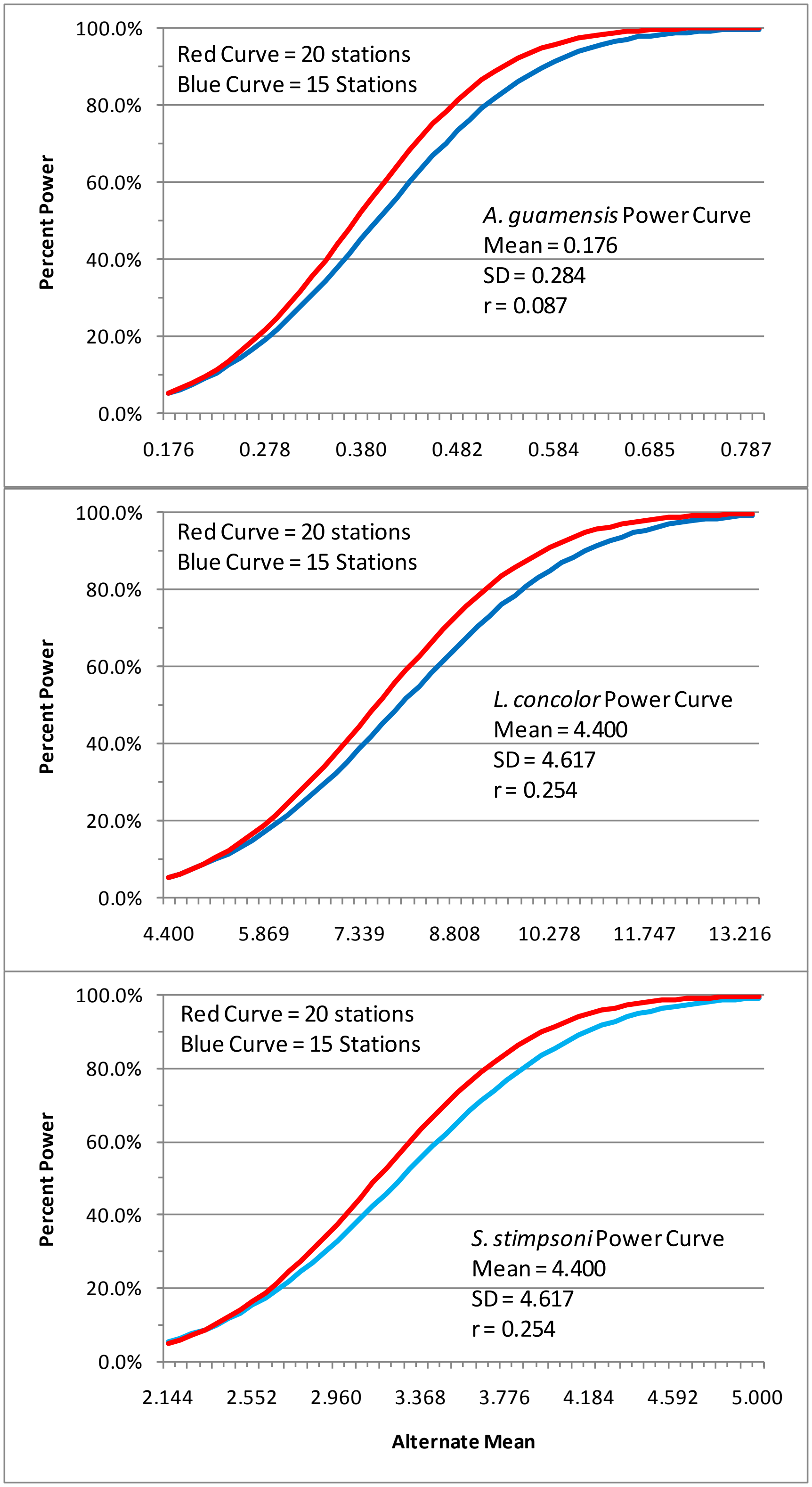

Figure 2.2. Power curve estimation for Molokai fish population data. Estimates based on two-sided tests with an α = 0.1 comparison between means.

Table 2.6 Power to detect a difference between population means estimations for three fish species on Molokai. Estimates based on two-sided tests with an α = .1 comparison between means. Estimates use either 15 sampling stations with 8 fixed and 7 random or 20 sampling stations with 10 fixed and 10 random.

Species	15 stations	20 stations
A. guamensis	17%	20%
L. concolor	28%	33%
S. stimpsoni	50%	59%

Further parametric statistical power estimations using the Skalski equations (Skalski 2005) on the data from Maui yield additional information about the ability to detect trend over time. This is distinguished from the ability to detect a difference in the means, in that a trend estimates continuing small changes in mean over time, as opposed to specific differences between two means. Data from Maui were modeled over a 25 year period (Table 2.7).

Table 2.7. Modeled power to detect change over time with specific confidences based on actual data from Maui, following the I&M protocol recommendations (15 sites 8 fixed and 7 random). Relative change value is read as x% chance of detecting a population change of y% with a confidence of 1-α% in z years (i.e. 0.797 on the table corresponds to a 79.7% [or read 80%] chance of detecting a 50% change in the population with 95% confidence in 20 years).

Power Output					
Relative Change					
α=0.05	**5 yrs**	**10 yrs**	**15 yrs**	**20 yrs**	**25 yrs**
10%	0.110	0.121	0.131	0.142	0.152
25%	0.159	0.228	0.286	0.344	0.398
50%	0.321	0.548	0.689	0.797	0.868
α=0.10					
10%	0.215	0.230	0.243	0.256	0.268
25%	0.290	0.369	0.435	0.496	0.551
50%	0.507	0.704	0.818	0.891	0.935

Based on these results it would initially appear that the ability to detect trends over time has a relatively low statistical power. However, this sample design increases in the ability to detect change over time, especially larger changes (such as 50%) that are probably more ecologically relevant. Following this protocol results in a minimum of an 11% chance of detecting a 10% change in the fish population means in 5 years with 95% confidence based on the current variability, as well as an 82% chance of detecting a 50% population shift in 15 years with 90% confidence. Changes in population may very likely bring about changes in variability. If there is a decrease in population, power would correspondingly increase. The Skalski power equations allow for varying variability over time, calculating power by using a mean of the variances for each monitoring event, and a corresponding mean of the means.

Targeted Detection Level

Based on the analysis of the existing data sets and incorporating logistical and fiscal constraints, the targeted detection level is ±50% of the baseline population mean for all biological populations, expressed as a relative measurement of change. For example, in regions where a baseline parameter is 2.4 fishes/m^2, our target detection level is ± 1.2 fishes/m^2 change in absolute value (50% relative).

Quality Assurance of Data

This protocol takes a multi-phased approach to quality assurance. The first phase of this approach is training (SOP #7: "Training Field Personnel" provides details of the training process). Prior to any fieldwork, all individuals participating in the fieldwork must have thorough understanding of the field sampling activities. This will be accomplished by having all crew members read the protocol and attend training each year. In addition, crew members should always carry a copy of the SOPs pertinent to the sampling location

Once in the field, phase two of the quality assurance plan will begin. The crew should carry at least one waterproof copy of the species identification key (preferably one for each surveyor) to verify species identification. An in-field examination will verify ability to identify different species. When field instrumentation is being used to collect data measurements, both a data recorder and an instrument operator will be needed. The recorder will always repeat back the data on each measurement to verify that the data was communicated and recorded correctly.

After data collectors return from the field, the data sheets will be washed, dried, and then scanned into a .pdf file, with the original sent to, and stored by, the PACN Aquatic Ecologist for a minimum of three years. The data will be entered into the computer by the Aquatic Biological Technician, or another available biological technician. A technician will then verify 100% of the data entries by comparing them to the data sheets for each station to ensure that no errors were made in the entry of the data. All errors will be corrected following standard procedures described in Chapter 4 (Data handling, analysis and reporting). The data will then be certified for analysis.

Chapter 3: Field Methods

Field Season Preparations

The Field Lead (Aquatic Biological Technician) and Project Lead (PACN Aquatic Ecologist) should be thoroughly familiar with the objectives of the stream monitoring protocol. They should also have a solid working knowledge of all field sampling methods and techniques listed in this protocol. The Field Lead is responsible for the majority of field season preparations, but may be assisted in some tasks by the Project Lead.

Training

An important component of pre-season preparation is adequate training of the field crew. Because year-to-year consistency in implementing the protocol directly affects the quality of the monitoring data and their ability to demonstrate trends in the system, the need for high-quality training cannot be overemphasized. SOP #7: "Training Field Personnel" provides details on hiring and training personnel. The most essential component for the collection of credible, high-quality data is a competent observer. As a result, field crew training is a critical component of the monitoring program. Each observer should receive extensive training before the field season, and should periodically be tested for quality assurance.

Field Schedule

A sampling timeframe has been established for each park (Appendix #8: "Recommended Field Sampling Schedule"). This is coordinated with water quality monitoring, and has been selected to avoid the times of likely stream flooding. A tentative schedule should be constructed for the entire field season, taking into account all logistical considerations. Ultimately, the sampling scheduling should provide a plan for the entire season, but flexibility for unforeseen circumstances should be built into the schedule.

Supplies and Equipment

All of the necessary supplies for the season should be located and inspected to ensure that they are in adequate condition. This includes, for example; field guides, data forms, GPS units, maps, and all sampling equipment. Supplies should be grouped together in containers according to sampling activity, and each container should have an attached check-list of all of the necessary supplies.

All field equipment should be available and organized at least one month before field work is scheduled to begin. All equipment should also be examined for functionality and completeness before fieldwork begins. For example, sampling traps should be clean and free of holes, and a sufficient supply of replacement batteries and pencils should be available. Wetsuits and waders should be inspected to ensure that they are clean and free of tears.

Each field season a new set of data forms will need to be photocopied onto waterproof paper. In addition, station and quadrat, transect, or pool locations should be determined and copied onto waterproof paper. This will include permanent sampling stations as well as randomly generated ones for a particular site visit.

It is very important that all gear (including personal items such as boots or tabis) be thoroughly cleaned to avoid inadvertently transporting introduced species to a new location.

Permits

Obtaining all necessary permits is the responsibility of the Aquatic Biological Technician, who may be assisted by park staff or the Project Lead. Permits can be especially time consuming to obtain and therefore, applications for these permits should be submitted well before the season begins. Scientific collecting permits need to be obtained from the appropriate state or territory agency, and from each individual park where sampling will occur.

Logistics

Adequate preparation and advance planning is essential for a successful trip to the field (see SOP #2: "Preparation for Field Sampling"). Each park and each stream will require a number of pre-trip arrangements, well in advance of the planned sampling event, such as acquiring proper permits (both from the park and from the state or territory), notifying park personnel of the planned monitoring trip, arranging transportation to the park (airplane flights, vehicle rentals, boat transportation), making housing or camping arrangements, and arranging transportation within the park. In some instances local agency staff or park staff may be available (or necessary) for assistance. At least two months prior to starting fieldwork, appropriate persons in the park should be contacted (Chief of Resource Management, Chief Ranger, other applicable staff that may be required to assist). Details, recommendations, and contacts for managing these logistics are provided in Appendix 5: "Logistics."

Overview of Sampling Methods for Pacific Island Streams

A number of sampling methods have been used for sampling Pacific island streams. The most common methods include: (1) snorkeling, using either quadrats (Hodges 1994; Brasher 1996, 1997c; Baker and Foster 1992; Higashi and Nishimoto 2007), transects (Kido et al. 1999), or swimming through a reach (Government of Guam Department of Aquatic and Wildlife Resources, Brent Tibbats, Aquatic Biologist, personal communication, 2008); (2) electrofishing (Cook 2004; Brasher et al. 2006), and (3) trapping (Hodges 1994; Cook 2004). Sampling in PACN streams will include a combination of these methods based upon logistics and previous sampling efforts in a given park stream.

Conducting Field Surveys—Fish, Shrimp, and Snails

The steps for conducting field surveys are outlined in SOP #8: "Conducting Surveys on Tau, American Samoa", SOP #9: "Conducting Surveys on Tutuila, American Samoa", SOP #10: "Conducting Surveys in Guam", and SOP #11: "Conducting Surveys in Hawaii". Associated Data Sheets for each island are in Appendices #9-11. Detailed directions to the sampling sites can be found in Appendix 5: "Logistics". The first step in conducting field surveys is setting up the sampling reach. After the sampling reach has been located in the stream (SOP #3: "Locating Sampling Stations"), the reach is marked with flagging tape and the location documented with a GPS (SOP #4: "Using Garmin Global Positioning System (GPS) Units"). It is helpful at this point to mark with flagging tape the five sections along the reach where shrimp will be sampled (in American Samoa and Guam). Water quality sampling (see the Water Quality Protocol for details) is conducted at the top of the reach so that other sampling activities do not influence the water sample. A discharge measurement is made at this location as well. If there are a sufficient number of crew members the biota surveys can begin at the same time, and follow the order of fish sampling then shrimp sampling, followed by snail surveys. If specimens are collected for later identification, they are preserved in alcohol for follow-up packaging and transportation (SOP #24: After Field Procedures). Sampling always occurs from downstream to upstream. Lastly the habitat survey is conducted.

Conducting Surveys on Tau, American Samoa

Fish surveys are always conducted first (SOP #12: "Fish Surveys on Tau, American Samoa"). Ten randomly placed $1m^2$ quadrats are surveyed, each for three minutes. Using a mask and snorkel, the observer starts at the lowest quadrat and moves up stream as each is completed. All fish within each quadrat are recorded, noting species and size (total length) of each individual. Both native and introduced fish are recorded. If an introduced species is not able to be identified, observers should catch the specimen for expert identification. For shrimp surveys (SOP #13: "Shrimp (ula vai) Surveys on Tau, American Samoa"), the 30 m reach is divided into five sections each 6 m long. Observers use a variety of strategies including dip nets, opae nets, and turning over rocks, to collect all shrimp within the section. Shrimp are identified, measured, and returned unharmed to the stream. Snail surveys are conducted last, again utilizing 10 randomly placed $1m^2$ quadrats (SOP #14: "Snail (sisi vai) Surveys on Tau, American Samoa"). The observer first counts all of the egg capsules within the upper right $1/4m^2$ of the quadrat. The observers then proceed to collect and measure all snails, and return them unharmed to the stream, and then count all post-larval snails (less than 5mm) in the $1m^2$ quadrat.

Conducting Surveys on Tutuila, American Samoa

Fish surveys are not conducted in streams on Tutuila. For shrimp surveys (SOP #15: "Shrimp (ula vai) surveys on Tutuila, American Samoa"), the 30 m reach is divided into five sections each 6 m long. Observers use a variety of strategies including dip nets, opae nets, and turning over rocks, to collect all shrimp within the section. Shrimp are identified, measured, and returned unharmed to the stream. Snail surveys are conducted next, utilizing 10 randomly placed $1m^2$ quadrats (SOP #16: "Snail (sisi vai) Surveys on Tutuila, American Samoa). The observer first counts all of the egg capsules within the upper right $1/4m^2$ of the quadrat. The observers then proceed to collect and measure all snails, and return them unharmed to the stream, and then count all post-larval snails (less than 5mm) in the $1m^2$ quadrat.

Conducting Surveys on Guam

Fish surveys are always conducted first (SOP #17: "Fish (atot) Surveys in Guam"). Ten randomly placed $1m^2$ quadrats are surveyed, each for three minutes. Using a mask and snorkel, the observer starts at the lowest quadrat and moves up stream as each is completed. All fish within each quadrat are recorded, noting species and size (total length) of each individual. Both native (including eels) and introduced fish are recorded. If an introduced species is not able to be identified, observers should catch the specimen for expert identification. For shrimp surveys (SOP #18: "Shrimp (uhang) Surveys in Guam"), the 30 m reach is divided into five sections each 6 m long. Observers use a variety of strategies including dip nets, opae nets, and turning over rocks, to collect all shrimp within the section. Larger shrimp (*Macrobrachium lar*) are identified, measured, and returned unharmed to the stream. The smaller atyid shrimp are placed in marked sample jars filled with ethanol for later identification. Snail surveys are conducted last, within the five sections of the reach (SOP #19: "Snail (akaleha) Surveys in Guam"). This method is a full section search. One or two observers use mask and snorkel to observe and collect snails. Another person on shore identifies and measures each snail, and returns it to the stream unharmed. The in-water observers count snail egg capsules and post larval snails (< 5 mm) as they are observed moving along the segment and report them to the data recorder.

Conducting Surveys in Hawaii

Fish and shrimp surveys are conducted simultaneously in Hawaii (SOP #20: "Fish (oopu) and Shrimp (opae) Surveys in Hawaii"), and this is the first activity during the survey. Ten randomly placed $1m^2$ quadrats are surveyed, each for three minutes. Using a mask and snorkel, the observer starts at the lowest quadrat and moves up stream as each is completed. All fish within each quadrat are recorded, noting species and size (total length) of each individual. *Atyoida bisulcata* are counted but size is not estimated as they are all very small. Both native and introduced fish and shrimp are recorded. If an introduced species is not able to be identified, observers should catch the specimen for expert identification. In the case of large pools, quadrats are established around the perimeter of the pool. Snail surveys are then conducted, utilizing 10 randomly placed $1/16m^2$ quadrats (SOP #21: "Snail (hihiwai) surveys in Hawaii"). The observer first counts all of the egg capsules within the upper right $1/64m^2$ of the quadrat. The observers then proceed to collect and measure all snails, and return them unharmed to the stream, and then count all post-larval snails (less than 5mm) in the $1/16\ m^2$ quadrat.

Electrofishing for Fish and Crustaceans

In some instances, the PACN aquatic ecologist may choose to conduct an electrofishing survey on either Tutuila or Guam. This is an optional activity (SOP #22: "Electrofishing for Fish and Crustaceans"). Due to logistical and other considerations including the protection of native gobies, electrofishing will not be conducted on Tau or in Hawaii. Electrofishing works by temporarily stunning stream animals that are then quickly scooped out of the water with a sampling net and placed in buckets of aerated water. As soon as a reach has been sampled, organisms in the buckets are identified, measured, and returned to the stream unharmed.

Electrofishing may be conducted along selected reaches, typically in the same reach that the habitat survey is conducted. This activity requires additional training, additional gear (including safety gear), the presence of at least one person with appropriate certification and experience in electrofishing, and that all persons have first aid and CPR training. This activity also requires that extreme care be taken to avoid harming any animals.

Additional information about electrofishing is available in the Western EMAP protocol (Peck et al. 2006) and in the Fisheries Techniques book (Nielsen and Johnson 1983). It is recommended that all crew members who will electroshock read Chapter 8 on electrofishing by James Reynolds in the Fisheries Techniques book (Nielsen and Johnson 1983). Information on training programs is available from the U.S. Fish and Wildlife Service National Conservation Training Center website (http://training.fws.gov/BART/courses.html).

Conducting Field Surveys—Habitat

Physical habitat characteristics will be measured at the reach and the transect scale (as described in SOP #23: "Habitat Characterization at the Reach and Transect Scales"). This monitoring protocol is compatible with USGS guidelines for habitat assessments as part of the NAWQA program (Fitzpatrick et al. 1998) found electronically at http://water.usgs.gov/nawqa/ protocols/ bioprotocols.html) and the U.S. Environmental Protection Agency (EPA) Environmental

Monitoring and Assessment Program (EMAP) (see Peck et al. 2006, found electronically at http://www.epa.gov/wed/pages/publications/authored/EPA620R-06003EMAPSWFieldOperationsManualPeck.pdf), as well as habitat assessments being conducted in National Parks in the Colorado Plateau (Brasher et. al, in press).

Reach length for habitat characterization corresponds to the sampling reach for the fauna (30 meters). If possible, all physical habitat measurements should be made at each site on the same day that faunal surveys are conducted. Within each reach, six equally spaced transects will be established perpendicular to the direction of flow. Habitat will measured at 3 transects in Samoa and Hawaii and 6 transects in Guam.

Reach scale measurements include curvilinear reach length, geomorphic channel units (e.g. riffle, run, pool, etc.) and riparian land use (anthropogenic alterations and disturbances). Transect measurements include dominant habitat type, wetted channel width, riparian canopy closure, and substrate size estimation (pebble count). In addition, five point measurements are made across each transect of water depth and velocity.

Conducting Field Surveys—Water Quality and Discharge

Sampling for the stream protocol will be co-located with sampling for the water quality protocol, which includes measurements of both water quality and discharge.

After Field Activities

Post-field procedures fall into five categories: (1) equipment, (2) data management, (3) summaries of field notes or trip reports, and (4) reporting scientific collecting activities. These activities are detailed in SOP #24: “After the Field Season”.

Chapter 4: Data Handling, Analysis, and Reporting

Data handling, analysis, and reporting are treated as three interrelated steps in managing stream macrofauna monitoring information. Additional details and context for this chapter may be found in the PACN Data Management Plan (Dicus 2006), which describes the overall information management strategy for the network. The PACN website[1] also contains guidance documents on various information management topics (e.g., report development, GIS applications, GPS use).

Project Information Management Overview

Project information management may be best understood as an ongoing or cyclic process, as shown in Figure 4.1. Specific yearly information management tasks for this project and their timing are described in Appendix #12: "Yearly Project Task List." Readers may also refer to each respective chapter section below for additional guidance and instructions.

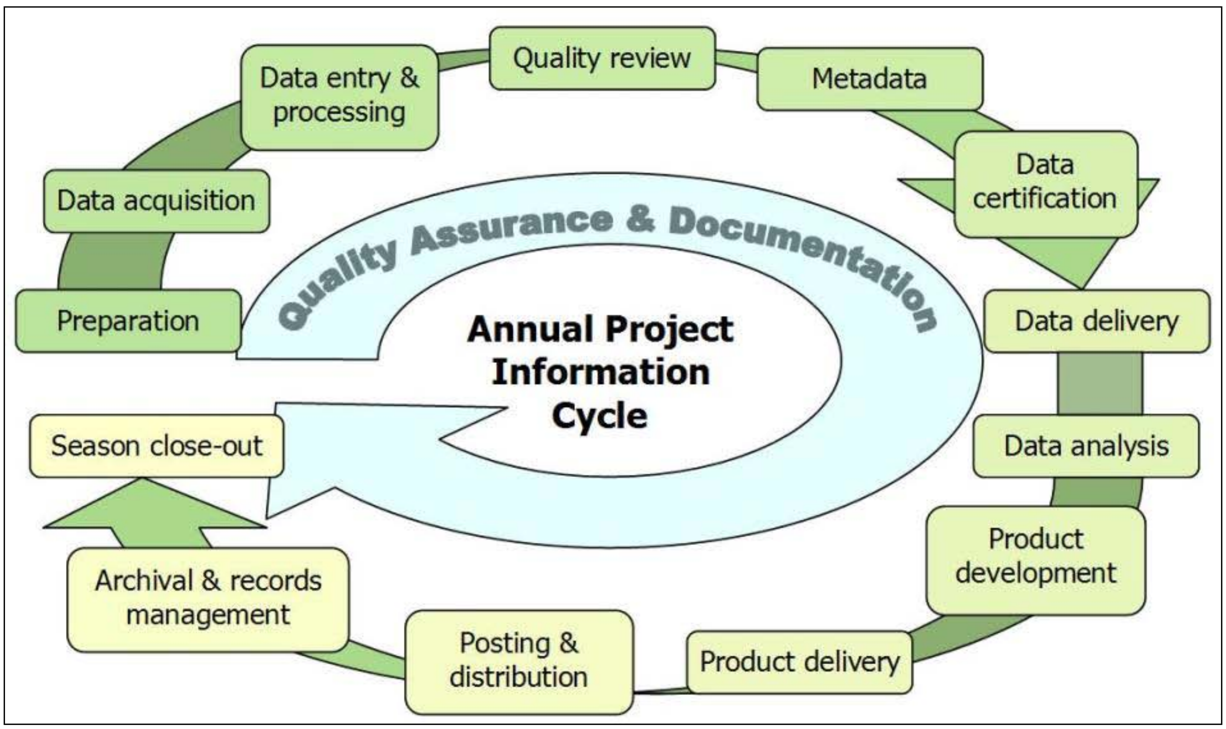

Figure 4.1. Idealized flow diagram of the cyclical stages of project information management, from pre-season preparation to season close-out. Note that quality assurance and documentation are thematic and not limited to any particular stage of the information life cycle.

The stages of this cycle are described in greater depth in later sections of this chapter, but can be briefly summarized as follows:

- *Preparation* – Training, logistics planning, printing forms and maps
- *Data acquisition* – Field trips to acquire data
- *Data entry & processing* – Data entry and uploads into the working copy of the database, GPS data processing, etc.

[1] http://www1.nature.nps.gov/im/units/pacn/data.cfm

- *Quality review* – Data are reviewed for quality and logical consistency
- *Metadata* – Documentation of the year's data collection and results of the quality review
- *Data certification* – Data are certified as complete for the period of record
- *Data delivery* – Certified data and metadata are delivered for archival and uploaded to the master project database
- *Data analysis* – Data are summarized and analyzed
- *Product development* – Reports, maps, and other products are developed
- *Product delivery* – Deliver reports and other products for posting and archival
- *Posting & distribution* – Distribute products as planned and/or post to the Integrated Resource Management Applications Portal (IRMA Portal).
- *Archival & records management* – Review analog and digital files for retention (or destruction) according to NPS Director's Order 19[2]. Retained files are renamed and stored as needed.
- *Season close-out* – Review and document needed improvements to project procedures or infrastructure, complete administrative reports, develop work plans for the coming season

Pre-season Preparations for Information Management

Set up Project Workspace

A section of the networked PACN server at is reserved for this project, and access permissions are established so that project staff members have access to needed files within this workspace. Prior to each season, the Project Lead should make sure that network accounts are established for each new staff member, and that the Data Manager is notified to ensure access to the project workspace and databases. If network connections are too slow for efficient data entry and processing, individual staff members may set up a workspace on their own workstation, with periodic data transfer to the PACN server. Daily backups of the workstation to an external hard drive will ensure that no data is lost. Additional details may be found in SOP #25: "Workspace Setup and Project Records Management".

GPS Loading and Preparation

The GIS Specialist and Project Lead should work together to ensure that target coordinates and data dictionaries are loaded into the GPS units prior to the onset of fieldwork, and that GPS download software is available and ready for use. Additional details on GPS use and GPS data handling may be found in SOP #4: "Using Garmin Global Positioning System (GPS) Units", SOP #5: "Downloading and Uploading Data between Garmin GPS and ArcGIS", SOP #6: "Using the Ricoh GPS Camera", and on the PACN website[3].

Implement Working Database Copy

Prior to the field season, the Data Manager will implement a blank copy of the working database and ensure proper access on the part of the project staff. Refer to Overview for Database Design (below) for additional information about the database design and implementation strategy.

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[2] http://data2.itc.nps.gov/npspolicy/DOrders.cfm
[3] http://www1.nature.nps.gov/im/units/pacn/gis/SOP.cfm

Overview of Database Design

PACN data management staff designed customized relational database applications to store and manipulate the data associated with this project. The design of the stream macrofauna monitoring database follows the hierarchical data table organization of the Natural Resource Database Template[4], the standard for the NPS I&M Program (see the data dictionary and other documentation in Appendix #13: "Database Documentation"). The PACN data management staff is responsible for development and maintenance of the database, including customization of data summarization and export routines.

The database is divided into two components: (a) one for entering, editing and error-checking data for the current season (i.e., the "working database copy"), and (b) one that contains the complete set of certified data for the monitoring project (i.e., the "master project database"). A functional comparison of these two components is provided in Table 4.1.

Table 4.1. Functional comparison of the master project database and the working database

Project database functions and capabilities	Working database	Master database
Software platform for back-end data	MS Access	MS SQL Server or MS Access
Contains full list of sampling locations and taxa	X	X
Portable for remote data entry	X	
Forms for entering and editing current year data	X	
Quality assurance and data validation tools	X	X
Preliminary data summarization capabilities	X	
Full analysis, summarization and export tools		X
Pre-formatted report output		X
Contains certified data for all observation years		X
Limited editing capabilities, edits are logged		X
Full automated backups and transaction logging		X

Each of these components is based on an identical underlying data structure (tables, fields, and relationships, as documented in Appendix #13: "Database Documentation"). The working database is implemented in Microsoft Access to permit greater flexibility for computers with limited or unreliable network access. Eventually, the master database will be implemented in Microsoft SQL Server in order to take advantage of the backup and transaction logging capabilities of this enterprise database software.

Both components have an associated front-end database application ("user interface" with forms and queries) implemented in Microsoft Access. The working database application has separate screens for data entry, data review, and quality validation tools. The master database application contains the analysis and summarization tools, including pre-formatted report output and exports to other software (e.g., for analysis and graphics production). This front-end application arrangement allows for modification and update of the user interface with no disruption to data entry continuity. The improved front-end file can be distributed to data entry staff, who link it to the back-end file, discard the out-dated front-end file, and proceed with their data entry work.

[4] http://science.nature.nps.gov/im/apps/template/index.cfm

Under this arrangement, data entry staff has no need to open the back-end file, thereby reducing the risk of improper deletions or other inadvertent data loss occurring within the protocol-specific data tables. In addition, a multi-user environment can be accommodated by storing the back-end file on a server available to all users via a computer network.

During the field season, each project crew will be provided with their own copy of a working database into which they enter, process, and quality check data for the current season (refer to the next section and SOP #26: "Data Entry and Verification"). Once data for the field season have been certified they will be uploaded into the master database, which is then used to inform all reporting and analysis. This upload process is performed by the Data Manager, using a series of pre-built append queries.

Data Entry and Processing

The functional components for data entry into the working database are described in SOP #26: "Data Entry and Verification". Each data entry form is patterned after the structure of the field form, and has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged only to use these pre-built forms as a way of ensuring the maximum level of quality assurance.

Regular Data Backups

Upon opening the working database, the user will be prompted to make a backup of the underlying data (see SOP #26: "Data Entry and Verification"). It is recommended that this be done on a regular basis – perhaps every day that new data are entered – to save time in case of mistakes or database file corruption. These periodic backup files should be compressed to save drive space, and may be deleted once enough subsequent backups are made. All such backups may be deleted after the data have passed the quality review and been certified.

Data Verification

Analyses performed to detect ecological trends or patterns require data that are recorded properly and have acceptable precision and minimal bias. Poor quality data can limit detection of subtle changes in ecosystem patterns and processes, and may lead to incorrect conclusions. Quality assurance/quality control (QA/QC) procedures applied to ecological data include four procedural areas (or activities), ranging from simple to sophisticated, and inexpensive to costly:

- defining and enforcing standards for electronic formats, locally defined codes, measurement units, and metadata
- checking for unusual or unreasonable patterns in data
- checking for comparability of values between data sets
- assessing overall data quality
- To the greatest extent possible, the stream macrofauna database application incorporates QA/QC strategies involving the first activity (defining and enforcing standards). The database design and the allowable value ranges assigned to individual fields within the data tables help to minimize the potential for data entry errors and/or the transcription of erroneously recorded data. The other activities are integrated in the validation phase (see

Data Quality Review and SOP #27: "Post-Season Data Quality Review and Certification" for more details.)

Field Form Handling Procedures

As the field data forms are part of the permanent record for project data, they should be handled in a way that preserves their future interpretability and information content. To minimize the possibility of data loss, hardcopy data forms and field notebooks should be stored in a well organized fashion in a secure location, with photocopies and scanned data forms stored in a separate location (e.g., on the PACN data server). Refer to SOP #28: "Field Form Handling Procedures" for more details.

Image Handling Procedures

Photographic images should also be handled and processed with care. Refer to SOP #29: "Managing Photographic Images" for details on how to handle and manage these files.

GPS Data Procedures

The following general procedures should be followed for GPS data (see SOP #4: "Using Garmin Global Positioning System (GPS) Units" and Appendix #12: "Yearly Project Task List"):

1. GPS data should be downloaded by the field crew from the units at the end of each field trip and stored in the project workspace (see SOP #25: "Workspace Setup and Project Records Management").
2. Raw files should be sent in a timely manner to the GIS Specialist for processing and correction.
3. The GIS Specialist will process the raw GPS data and store the processed data in the project workspace.
4. The GIS Specialist will upload corrected coordinate information into the database and create any GIS data sets.

The Field Lead should periodically review the processed GPS data to make sure that any problems are identified early in the data collection process.

Data Quality Review

After the data have been entered and processed, they need to be reviewed by the Project Lead for quality, completeness, and logical consistency. The working database application facilitates this process by showing the results of pre-built queries that check for data integrity, data outliers and missing values, and illogical values. The user may then fix these problems and document the fixes. Not all errors and inconsistencies can be fixed, in which case a description of the resulting errors and why edits were not made is then documented and included in the metadata and certification report (see Metadata Procedures and Data Certification and Delivery and SOP #27: "Post-Season Data Quality Review and Certification").

Data edits after certification

Due to the high volume of data changes and/or corrections during data entry, it is not efficient to log all changes until after data are certified and uploaded into the master database. Prior to certification, daily backups of the working database provide a crude means of restoring data to the previous day's state. After certification, all data edits in the master database are tracked in an edit log (refer to Appendix #13: "Database Documentation") so that future data users will be aware of changes made after certification. In case future users need to restore data to the certified version, we also retain a separate, read-only copy of the original, certified data for each year in the PACN Digital Library (refer to SOP #30: "Product Delivery Specifications").

Geospatial Data
The Project Lead and GIS Specialist may work together to review the surveyed coordinates and other geospatial data for accuracy. The purpose of this joint review is to make sure that geospatial data are complete and reasonably accurate, and also to determine which coordinates will be used for subsequent mapping and fieldwork.

Metadata Procedures
Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition, and other characteristics of a given data set, both tabular and spatial. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all PACN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed, and synthesized.

At the conclusion of the field season (according to the schedule in Appendix #12: Yearly Project Task List), the Project Lead will be responsible for providing a completed, up-to-date metadata interview form to the Data Manager. The Data Manager and GIS Specialist will facilitate metadata development by consulting on the use of the metadata interview form, by creating and parsing metadata records from the information in the interview form, and by posting such records to national clearinghouses. Refer to SOP #31: "Metadata Development" for specific instructions.

Data Certification and Delivery
Data certification is a benchmark in the project information management process that indicates that: 1) the data are complete for the period of record; 2) they have undergone and passed the quality assurance checks (Quality Review); and 3) that they are appropriately documented and in a condition for archiving, posting and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies which may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. The Project Lead is primarily responsible for completing a PACN Project Data Certification Form, available from the Data Manager or on the PACN website. This brief form should be submitted with the certified data according to the timeline in Appendix #12: "Yearly Project Task List". Refer to SOP #27: "Post-Season Data Quality Review and Certification" and SOP #30: "Product Delivery Specifications" for specific instructions.

Data Analysis

Data analysis addresses data validation issues and helps translate raw data into meaningful management information. The two initial steps for all Pacific Island stream monitoring data that have been identified are summarization and establishing range of variation. These initial steps are encompassed in the larger construct of data management and data stewardship which are discussed in SOPs #25-31, and in SOP #32: "Data Analysis and Reporting". Ultimately, analyses of the monitoring data are intended to 1) detect long-term trends in size and abundance of freshwater fish and invertebrates, and 2) quantify associations among stream macrofauna size and abundance and their habitat by correlating habitat measures with observed biological data.

Analytical Approach

Two basic initial steps are identified in data analysis for this protocol: summarization, and establishing the range of variation. These steps are part of the larger data management and data stewardship which is discussed in SOPs #:25-31. There are two levels for evaluating the monitoring data: station level and stream level, both of which utilize descriptive statistics (Table 4.2). Additional data analysis includes trend assessment and synthesis. Quadrat (Hawaii and Tau) or segment (Guam and Tutuila) abundance and size data is used to calculate summary statistics and range of variation (mean and standard deviation) for biological data at each station. Similarly, transect data is used to calculate summarization and range of variation data for habitat characteristics (e.g. velocity, substrate characteristics, etc.). The station level data includes mean and standard deviation abundance, size, and habitat characteristic data at a given station over time. Stream level data includes mean and standard deviation abundance, size, and habitat characteristic data for each station along the longitudinal gradient in a stream at a given time.

Trend assessment integrates station or stream level abundance, size, and habitat characteristic summarization and range of variation data over time to detect change. Typically some form of regression approach is used to identify the slope or trend. In addition trend assessment can include multivariate statistics to integrate station and stream level abundance and size data with habitat characteristics. Synthesis examines relationships between temporal and spatial trends in stream macrofauna size and abundance, community structure, habitat characteristics, and water quality data. Station level, stream level, and trend assessments are described here. Synthesis will be addressed within and across multiple Vital Signs and is therefore left for network level or broader scientific consideration in the future.

Status and Trend Analyses

The primary analytical strategies of interest to managers are anticipated to be status and long-term trends assessment (change detection). SOP #32: "Data Analysis and Reporting" identifies the some specific processes and methods that could be used when preparing these analyses. The station and stream level analyses identified above are anticipated to be an initial step in the analytical process. Sites with historical data sets will need to be evaluated by the PACN Aquatic Ecologist to ensure that the correct conversion factors and metrics are utilized for comparisons with current data sets.

Additional analytical techniques (e.g., multivariate analysis) may also be employed beyond those specified here or in SOP #32: "Data Analysis and Reporting," primarily in collaboration with other agencies and researchers.

Table 4.2. Preliminary approaches to analyzing stream community data.

Analysis	Description	Responsible Party
Station Level	Quality assurance and control routines and calculation of statistics from monitoring data (abundance, size, habitat): Step 1 (Summarization): Measures of mean, median, variation, and other basic statistics. Include graphical presentation of data. Step 2 (Range of Variation): Establish historical or expected range of values, relation to relevant regulatory levels, confidence estimates.	Biological Technician with oversight by PACN Aquatic Ecologist and with assistance from park staff
Stream Level	Quality assurance and control routines and calculation of statistics from monitoring data (abundance, size, habitat): Step 1 (Summarization): Measures of mean, median, variation, and other basic statistics. Include graphical presentation of data. Step 2 (Range of Variation): Establish historical or expected range of values, relation to relevant regulatory levels, confidence estimates.	Biological Technician with oversight by PACN Aquatic Ecologist and with assistance from park staff
Trend Assessments	Step 1: Integration of station and stream level summary statistics over time, potentially using regression analysis. Step 2: Integration of station and stream level variation over time, potentially using regression analysis. Includes establishing a direction and rate of change of variation that may provide early warnings of trends in resources condition. Step 3: Integration of station and stream biological data with habitat characteristics and water quality parameters using a multivariate approach.	PACN Aquatic Ecologist and researchers from other institutions (e.g. USGS)

Reporting and Product Development

Refer to Appendix #12: "Yearly Project Task List" and SOP #30: "Product Delivery Specifications" for the complete schedule for project reports and other deliverables and the people responsible for them. Additionally, a checklist for data analysis and reporting tasks is included in Appendix 14: "Analysis Log File Checklist."

Report Content

A summary report will be produced annually for each stream/island, with a more detailed report produced every five years. Analysis is conducted at two levels: the station level and stream level, a trend assessment is conducted once adequate data is available. The annual report should:

- Calculate summary statistics and variance estimates for biological data (fish, shrimp, and snail size and abundance) by species using quadrat or segment data from each station.
- Calculate summary statistics and variance estimates for physical habitat characteristics across transects at each station.
- Present station level data at the stream level, for each station along the longitudinal gradient of a given stream.
- Provide detailed trend results for abundance for each species (after the initial five years of data have been collected) at the station and stream levels.

- When possible include synthesis level analyses such as multivariate techniques to summarize associations of biota with physical habitat or water quality data.
- Evaluate operational aspects of the monitoring program, such as whether any sampling locations need to be eliminated or moved due to access problems, whether the sampling period remains appropriate.

Detailed reporting guidelines and table structures are provided in SOP #32: "Data Analysis and Reporting".

A more in-depth analysis and report should be produced every five years. In addition to the above, the five-year report should also:

- Provide detailed trend results for biological and physical habitat data the station and stream levels.
- Synthesize data by examining patterns within and across Vital Signs (such as water quality data).
- Evaluate sampling data using accumulated data to determine optimal sample size and sample design for trend detection.

Standard Report Format

Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Annual reports will use either the Natural Resource Report or the Natural Resource Data Series template, and trend analysis and other peer-reviewed technical reports will use the Natural Resource Technical Report template. These templates and documentation of the NPS publication standards are available at the NPS Natural Resource Publications website[5]. An example of report content is provided in Appendix #15: "Pacific Islands Stream Monitoring Report: Example Summary of Vital Signs Data."

Review Products for Sensitive Information

Certain project information related to the specific locations of rare or threatened taxa may meet criteria for protection. In this case, the data should not be shared outside NPS except where a written confidentiality agreement is in place prior to data sharing. Before preparing data in any format for sharing outside NPS—including presentations, reports, and publications—the Project Lead should refer to the guidance in SOP #33: "Sensitive Information Procedures". Certain information that may convey specific locations of sensitive resources may need to be screened or redacted from public versions of products prior to release.

Product Delivery, Posting, and Distribution

Refer to SOP #30: "Product Delivery Specifications" for a schedule for project deliverables and detailed instructions on how to deliver final products. Upon delivery products will be posted to the IRMA Portal[6] as appropriate (refer to SOP #34: "Product Posting and Distribution" for more information).

[5] http://www.nature.nps.gov/publications/NRPM/index.cfm
[6] http://irma.nps.gov/App/Portal/Home

Holding Period for Project Data
To permit sufficient time for priority in publication, certified project data will be held upon delivery for a period not to exceed two years after it was originally collected. After the two year period has elapsed, all certified, non-sensitive data will be posted to the IRMA Portal. Note that this hold only applies to raw data, and not to metadata, reports or other products which are posted to IRMA Portal immediately after being received and processed.

Special Procedures for Sensitive Information
Products that have been identified upon submission by the Project Lead as containing sensitive information will either be revised into a form that does not disclose the locations of sensitive resources, or withheld from posting and distribution. When requests for distribution of the unedited version of products are initiated by the NPS, by a federal agency, or by a partner organization (e.g., a research scientist at a university), the unedited product (e.g., the full data set that includes protected information) may only be shared after a confidentiality agreement is established between NPS and the other organization. Refer to SOP #33: “Sensitive Information Procedures” for more information.

All official Freedom of Information Act (FOIA) requests will be handled according to NPS policy. The Project Lead will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

Archival and Records Management
All project files should be reviewed, cleaned up, and organized by the Project Lead annually. Decisions on what to retain and what to destroy should be made following guidelines stipulated in NPS Director’s Order 19, which provides a schedule indicating the amount of time that the various kinds of records should be retained. Refer to SOP #25: “Workspace Setup and Project Records Management”.

Season Close-out
After the conclusion of the field season, the Project Lead, Aquatic Biological Technician, Data Manager, and GIS Specialist should meet to discuss the recent field season, and to document any needed changes to the field sampling protocols, the working database application, or to any of the SOPs associated with the protocol. Refer to the section on Data Entry and Processing for additional close-out procedures not specifically related to project information management.

Chapter 5: Personnel Requirements and Training

Roles and Responsibilities

The Pacific Islands Stream Monitoring Protocol will be implemented using a combination of the existing PACN I&M Aquatic Ecologist (serving as the Project Lead), an Aquatic Biological Technician (serving as the Field Lead), additional technicians when available, and in-park NPS staff. Table 5.1 lists the current roles and responsibilities for individuals carrying out these tasks and Appendix 12: "Yearly Project Task List" lists specific yearly tasks for this project and their timing. Implementation of the Pacific Islands Stream Monitoring Protocol requires a team approach, with a minimum of three personnel for field activities (in most instances five people would be preferable for stream monitoring). The PACN Aquatic Ecologist is the primary liaison with the parks, ensuring this monitoring effort continues to address park management needs. One or more Biological Technicians will be part of the PACN team. The Aquatic Biological Technician assists the Aquatic Ecologist in coordination efforts, data management, quality assurance, and analysis and is responsible for pre- and post-field visit preparations, and assisting in fieldwork. The PACN Aquatic Ecologist and other PACN staff help facilitate Vital Sign monitoring operations, ensure database management, conduct detailed status and trend analyses and reporting, and provide other reporting and operational assistance at a network and national level. Researchers from universities and other agencies (such as the U.S. Geological Survey) may also assist in data analysis and reporting activities. Individual park staff may provide some in-park coordination for field efforts as well as participate in sampling activities.

Project Lead

The PACN Aquatic Ecologist will serve as the Project Lead and will be responsible for implementing this monitoring protocol with the assistance of PACN Aquatic Biological Technicians and in some instances, park staff. The Project Lead will be the PACN I&M Program's lead point of contact. The Project Lead will be responsible for overseeing field implementation, data entry, data verification, data analysis, final report preparation and dissemination, and ensuring that data has been managed and archived appropriately. The Project Lead works with the PACN Data Manager to ensure that the data management needs of this protocol are met, that data products are made available according to schedule, and that any required edits to archived data are documented according to network standards.

The Project Lead will be responsible for all I&M programmatic reporting including annual trend analysis and park-based status reports. The Project Lead will also communicate budget and other program needs to the PACN Program Manager. The Project Lead will coordinate periodic programmatic reviews of this protocol to ensure the continuing relevance and applicability of the protocols and data, and suggest and implement changes to the protocol design when necessary.

Overall field program coordination, analysis, and reporting to the each park's resource manager and/or designated ecologist is the responsibility of the Project Lead. Each year, the Project Lead will review the sampling activities as well as data management and analysis, to help ensure that operations and results meet the guidelines outlined in this protocol. The Project Lead and the Field Lead (Aquatic Biological Technician) will review the protocol and previous year's field notes prior to sampling at a given park each year.

Table 5.1 Personnel Roles and Responsibilities for the PACN Pacific Islands Stream Monitoring: Fish, Shrimp, Snails and Habitat Characterization.

Role	Responsibilities
Project Lead/Aquatic Ecologist	Project oversight and administration Track project objectives, budget, requirements, and progress toward project objectives Facilitate communications between NPS and collaborators Coordinate and ratify changes to protocol Assist in training field crews Assist Field Lead in performing data summaries and analysis Conduct interpretation and report preparation (with assistance from Field Lead) Review annual reports and other project deliverables for completeness and compliance with Inventory and Monitoring Program specifications Maintain and archive project records Project operations and implementation Certify each season's data for quality and completeness Complete reports, metadata, and other products according to schedule
Data Analyst	Perform data summaries and analysis, assist interpretation and report preparation
Field Lead/Aquatic Biological Technician	Train and ensure safety of field crew Plan and execute field visits (including contact with park staff) Acquire and maintain field equipment Acquire necessary permits and compliance Oversee data collection and entry, verify accurate data transcription into database Conduct data summaries and analysis (with assistance from the Project Lead) Assist Project Lead with interpretation and report preparation Complete a field season report Review protocol and previous year's field notes prior to the start of sampling
Technicians	Collect, record, enter and verify data
Data Manager	Consult on data management activities Facilitate check-in, review, and posting of data, metadata, reports, and other products to national databases and clearinghouses according to schedule Maintain and update database application Provide database training as needed
GIS Specialist	Consult on spatial data collection, GPS use, and spatial analysis techniques Facilitate spatial data development and map output generation Work with Project Lead and Data Analyst to analyze spatial data and develop metadata for spatial data products Primary steward of GIS data and products
Program Manager	Review annual reports for completeness and compliance with I&M standards and expectations
Park staff	Facilitate logistics planning and coordination Ensure project compliance with park requirements Review reports, data and other project deliverables

Aquatic Biological Technician

The Aquatic Biological Technician will serve as the Field Lead, and will be responsible for assisting in both pre- and post-field activities. The primary responsibilities will be logistical coordination, field data collection, data entry, data management, and equipment management. The Aquatic Biological Technician will travel to parks as needed to assist with and conduct on-site field monitoring. Data will be entered by the technician into an established database. This individual will conduct some data analyses for annual reporting and participate in the preparation of annual data reports. The Aquatic Biological Technician may be assisted in data collection and data entry activities by other staff technicians, when available.

Park-Based NPS Staff
In some cases, existing park-based resource staff will assist the Project Lead and Field Lead with field-related activities, including data collection. Additionally, park staff may be trained to conduct and carry out monitoring when logistical constraints preclude the PACN Aquatic Ecologist (Project Lead) or the Aquatic Biological Technician (Field Lead) from conducting monitoring directly.

PACN Data Manager
The Data Manager will provide guidance and, if appropriate, assistance with data management, archiving, adaptive database design, maintenance, database integration, and data distribution. The PACN Data Manager will not be responsible for day-to-day activities required implementing this protocol, but will review the data and database-related practices of the Project Lead and the Aquatic Biological Technician to ensure they meet programmatic and Vital Sign standards and needs.

PACN GIS Specialist
The GIS Specialist will generate individual park-based sampling maps with geo-referenced sampling points provided by the Project Lead. The PACN GIS Specialist will also be responsible for generating mapping locations and geo-referenced graphical representations of spatial analyses for reports.

PACN Program Manager
The PACN Program Manager will be responsible for general oversight of the stream monitoring program. This includes periodic review of reports, decisions regarding allocation of funds and staffing plans, and the overall quality and performance of the Project Lead. The Program Manager is responsible for bringing any general monitoring issues beyond the scope of the Project Lead responsibilities to the governing body of the PACN (PACN Board of Directors).

Qualifications and Training
All technical field staff will be trained in, and responsible for, familiarity with the SOPs, the protocol narrative, and the protocol database. Periodic training and recertification are required. These items are outlined in SOP #7: “Training Field Personnel”, and involve a minimum of reading the full protocol (including narrative, SOPs, and appendices), receiving instruction in the proper completion of all data forms, and receiving on-site training by the Project Lead in field implementation. Prior to the start of field sampling, all participating field personnel must refresh their methodological skills by reviewing SOP #7: “Training Field Personnel” and ensure their certifications are complete and up to date.

Each position requires minimum background knowledge, skills, and abilities. The PACN Aquatic Ecologist will serve as the Project Lead. This position requires a graduate degree or equivalent experience in related discipline(s) (e.g., aquatic ecology, or other applicable biological/natural science field), experience in the field data collection, experience in statistics, data manipulation, and data management.

Park staff will typically be a park-based ecologist or resource manager, with experience and expertise that enables them to assist with all aspects of the program.

The Aquatic Biological Technician will serve as the Field Lead. This position requires at minimum a bachelor's degree or equivalent experience in related discipline(s) (e.g., biological sciences or natural history). Anyone filling this position must be capable of underwater field operations, data collection, data management, post-processing, basic data analysis, and equipment maintenance.

The Data Manager requires experience in database management, records certification, SQL programming, and archiving. This position is hired through the PACN Program Manager and is responsible for the entire PACN data management program. The minimum qualification is a bachelors degree in computer science or related concentration, or other equivalent experience, plus experience with the aforementioned skills.

The GIS specialist requires a Bachelors degree in computer science or related concentration, plus specific experience with geo-referencing databases and programs. This position also requires experience in geographic information systems.

Chapter 6: Operational Requirements

This chapter outlines preparatory work necessary before monitoring occurs (pre-monitoring documents), annual workloads and field schedule, facility and equipment needs, start-up costs, and annual budgets.

Pre-Monitoring Task

Pre-Monitoring Documents

Preparations for annual monitoring activities are summarized in SOP #2: "Preparation for the Field Sampling." At minimum, the Project Lead, and Aquatic Biological Technician should review all SOPs, associated databases, and the previous year's field notes prior to initiating annual monitoring activities. As needed, the protocol narrative, appendices, SOPs, and databases shall be updated prior to initiating field-based monitoring efforts.

Annual Workload and Field Schedule

Field sampling will be conducted annually. Scheduling sampling events can be difficult because of inclement weather, particularly weather bringing rain that raises the stream level above low-flow conditions, personnel workloads, or other factors. In order to better accommodate these factors, a three-week window will be used to plan when monitoring may occur at each park. Table 6.1 outlines a schedule of programmatic and monitoring related activities for this Vital Sign.

Facilities and Equipment

Facility support, office space, and supply requirements will be coordinated through the PACN Program Manager, in consultation with the Aquatic Ecologist. Field equipment and supply needs are outlined in SOP #2: "Preparation for the Field Sampling". In some instances, parks will provide space for long-term storage of field gear.

Table 6.1 Annual (fiscal year) schedule of monitoring activity benchmarks, with responsible individual(s) identified.

Month	Preparation & Maintenance	Responsible Party
Oct	Finalize budget for fiscal year	Project lead (PACN aquatic ecologist)
Nov	Initial annual data analysis and report writing	Project lead, assisted by aquatic biotech (field lead), and park staff
Nov	Permit Requests	Project lead, assisted by aquatic biotech
Dec	Submit necessary IAP/IAGP's	Project lead
Jan	Complete annual reporting (protocol summary and annual analysis) – may be completed earlier, this is the annual report for the previous year.	Project lead, assisted by aquatic biotech
Jan	Establish monitoring dates and personnel commitments.	Project lead, aquatic biotech, and park staff
Feb	Re-evaluate budget status for fiscal year	Project lead
Feb	Review protocol and previous year's field notes	Aquatic biotech, assisted by project lead
Feb	Training/safety needs evaluation for Project Lead, Aquatic Biological Technician, NPS Lead and park-based staff	Project lead, aquatic biotech, and park staff
Mar	Mid-year equipment evaluation. Begin equipment purchases	Aquatic biotech, assisted by project lead
Apr	Field Monitoring WAPA	Aquatic biotech, other technicians, may also be assisted by park staff or project lead
May	Write contracts/agreements for next FY work	Project lead
Jun	Field Monitoring HALE	Aquatic biotech, other technicians, may also be assisted by park staff or project lead
Jul	Field Monitoring KALA	Aquatic biotech, other technicians, may also be assisted by park staff or project lead
Aug	Plan budget for next FY	Project lead
Sep	Field Monitoring NPSA	Aquatic biotech, other technicians, may also be assisted by park staff or project lead
Sep	Close out year-end budget	Project lead
Sep	End of the year equipment evaluation	Aquatic biotech

Start-up Costs

Start-up costs are identified separately from annual, implemented monitoring, and maintenance expenses. Start up costs related to the Aquatic Biological Technician are provided in Table 6.2.

In general, start-up costs are anticipated to be somewhat substantial for some field equipment related to the water quality monitoring (covered in a separate protocol), as well as specific to this protocol (flow meter, GPS equipment, and so forth). It is not feasible to incorporate all start-up costs into a single fiscal year because a substantial amount of the cost is in the monitoring equipment (approximately $35,000 per park for all parks to have their own equipment), so a phase-in plan will be used with this protocol. Some equipment will be centrally located with I&M and moved between parks by the Field Lead. Annually recurring fixed costs include equipment maintenance, salaries, training, certification, and travel-related expenses.

Table 6.2. Start-up costs.

Start-up Costs for Aquatic Biological Technician	
Equipment	$2,500
Training and certification	$2,000
Computer and software	$3,500
Desk and office supplies	$2,000
Position rating and recruitment	$3,000
TOTAL	$13,000

Annual Budget

Annual expense estimates for the stream monitoring protocol are outlined in Table 6.3 and are expected to be approximately $66,939 for 2010, of which, approximately 30% is anticipated to be utilized for data management, data analysis, and reporting. These expenses are based on annual sampling in each park, and a base staff of an Aquatic Biological Technician and the PACN Aquatic Ecologist, with assistance from existing park-based staff. Time for data entry, analysis and reporting is also included. As this protocol, sample design, field visit schedule, and safety and other considerations evolve, this budget will need refining. Estimates presented below are based on 2010 expenses.

Table 6.3. Annual itemized expenses for the Pacific Islands Stream Monitoring Protocol by park.

Parks	**HALE**	**KALA**	**NPSA**	**WAPA**
Salaries				
Project Lead	$ 5,485	$ 5,485	$ 5,485	$ 5,485
Field Lead	$ 3,002	$ 3,002	$ 3,002	$ 3,002
Data Manager	$ 458	$ 458	$ 458	$ 458
GIS Specialist	$ 114	$ 114	$ 114	$ 114
Program Manager	$ 326	$ 326	$ 326	$ 326
Sub-Total	$ 8,288	$ 8,288	$ 8,288	$ 8,288
Travel				
Camping Cost	$ 600	$ 600	$ -	$ -
Hotel Cost	$ -	$ -	$ 3,700	$ 4,200
Per Diem Cost	$ -	$ -	$ 1,700	$ 2,000
Airfare Cost	$ 800	$ 800	$ 4,000	$ 4,000
Vehicle cost	$ 1,000	$ 600	$ 700	$ 700
Sub-Total	$ 2,400	$ 2,000	$ 10,100	$ 10,900
Equipment & Supplies				
Field Equip.	$ 100	$ 100	$ 100	$ 100
Crew Equipment	$ 700	$ 700	$ 700	$ 700
Sub-Total	$ 800	$ 800	$ 800	$ 800
Other				
Training	$ 100	$ 100	$ 100	$ 100
Office necessities	$ 100	$ 100	$ 100	$ 100
Sub-Total	$ 200	$ 200	$ 200	$ 200
Totals	$ 11,688	$ 11,288	$ 19,388	$ 20,188
Grand Total		$66,939		

These expenses are for direct implementation of the monitoring protocol, and are outlined below in detail. These include salary (with COLA and benefits), travel, computer and office supplies, office space, personal equipment, and mandatory training. When actively monitoring, the Aquatic Biological Technician's time as Field Lead is anticipated to be devoted to this Vital Sign, and the salary amounts in Table 6.3 reflect this. Personnel salaries were assumed to be GS-7, step 5, using the 2010 pay schedule for all of park technicians and GS-7 step 4 for the Field Lead. Personnel salaries were assumed to be GS-11, step 5, using the 2010 pay schedule for the Data Manager and GIS Specialist. Again, using the 2010 pay schedule, the Project Lead was assumed to be GS-12, step 5 and the Program Manager was estimated to be a GS-13, step 5. These costs were based on the following estimate of days required to complete protocol work (table 6.4):

Table 6.4. Annual requirements for staffing of the Pacific Islands Stream Monitoring Protocol: anticipated work days for identified personnel in each park.

Personnel	HALE	KALA	NPSA	WAPA
Project Lead	20	20	20	20
Field Lead	20	20	20	20
Data Manager	2	2	2	2
GIS Specialist	0.5	0.5	0.5	0.5
Program Manager	1	1	1	1

For the Project Lead and park-based staff, existing funds will be used to support these individuals' personnel costs and associated supplies, travel, and training expenses. The expenses directly related to this protocol are identified in Table 6.3. Costs associated with existing park-based staff are not incorporated, as these positions already exist with assigned duties not related to this Vital Sign. Should this collaboration with existing staff not be available, additional expenses should be expected. Not included in Table 6.3 are other park-based support personnel costs which are estimated to be GS-7, Step 5, for 6 pay periods/year [25% FTE] with 25% COLA, 25% hazard and 25% benefits per park ($39,000/year).

Procedures for Making/Implementing Changes to the Protocol

Revisions to the protocol narrative and SOPs are expected over time. Explicit documentation of these changes is critical for proper acquisition, processing, interpretation, and analysis of the data. Procedures for changing the protocol narrative and related SOPs are documented in SOP #35: "Revising the Protocol". The Protocol Narrative and all SOPs are labeled with version numbers and included in a Revision History Log (see Appendix #16: "Revision History Log"). Changes to either document type are to be accompanied by changes in version numbers. Version numbers and dates, the changes, reasons for the changes, and the author of the changes are to be recorded in the Revision History Log. The updated version numbers must be recorded in the PACN Stream Monitoring Master Version Table and provided to the Data Manager for proper updating of the Master Version Table database.

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Appendix 1: Species identification guide for American Samoa

The species identification guide to be used for monitoring in American Samoa will be the guide created by Don Vargo (2009). It is important to note that this was not developed by the National Park Service, but is a technical report from the American Samoa Community College (http://www.ctahr.hawaii.edu/adap/ASCC_LandGrant/Dr_Brooks/TechRepNo55.pdf). This guide is intended to be used as a half page size booklet. The page numbering assumes a saddle stitch down the center fold.

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Appendix 2: Species identification guide for Guam

The shrimp identification guide is continuing to be developed. All crustaceans in Guam are currently collected, preserved and processed by a lab with professional identification capabilities. It is not at this time feasible for the staff of War in the Pacific National Historical Park to do all identifications in the field. The field identification guide will updated one the identification has come back from the lab. Future plans include training park staff in crustacean identifications in Guam when feasible.

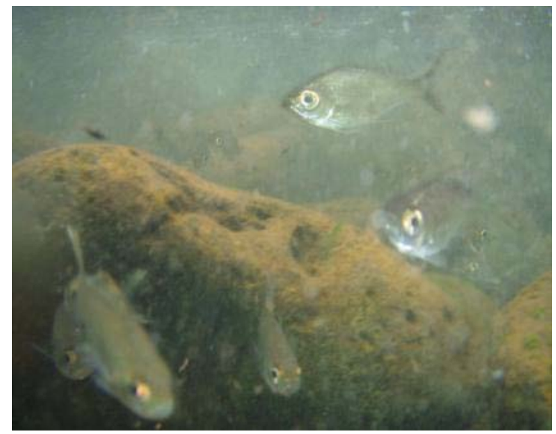
Stiphodon sp.

Sicyopus sp.

Sicyopterus lagocephalus
(Photo: Brent Tibbats Used by permission)

Eleotris fusca

Awaous guamensis

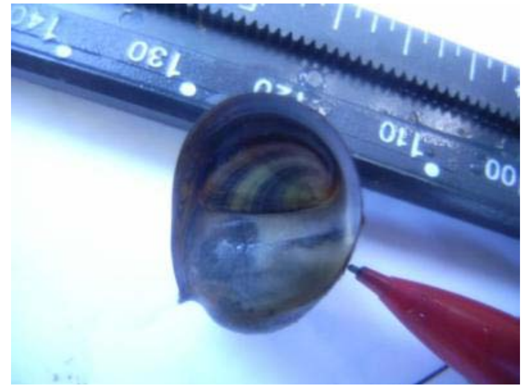


Kuhlia rupestris

Figure A.2.1. Guam fish identification guide.

Neritina pulligera

Neritina variegata



Neritina squamipicta

Septaria porcellana (top)

Septaria porcellana (underside)

Nertina petiti

Figure A.2.2. Guam snail identification guide.

Appendix 3: Species identification guide for Hawaii

Lentipes concolor oopu alamoo

Sicyopterus stimpsoni oopu nopili

Awaous guamensis oopu nakea

Figure A.3.1. Hawaii stream species identification guide.

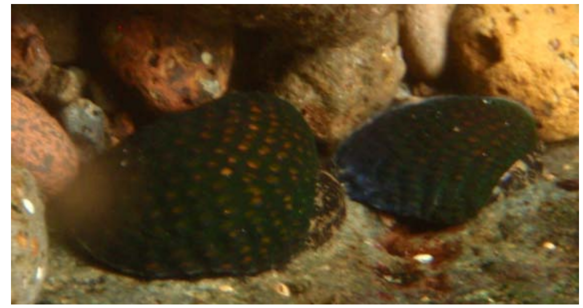
Eleotris sandwicensis oopu akupa

Stenogobius hawaiiensis oopu naniha

Kuhlia sandvicensis aholehole (flagtail)

Figure A.3.1. Hawaii stream species identification guide (continued).

Macrobrachium grandimanus opae oeaha



Neritina granosa Hihiwai

Atyoida bisulcata opae

Figure A.3.1. Hawaii stream species identification guide (continued).

Appendix 4: Introduced species identification guide

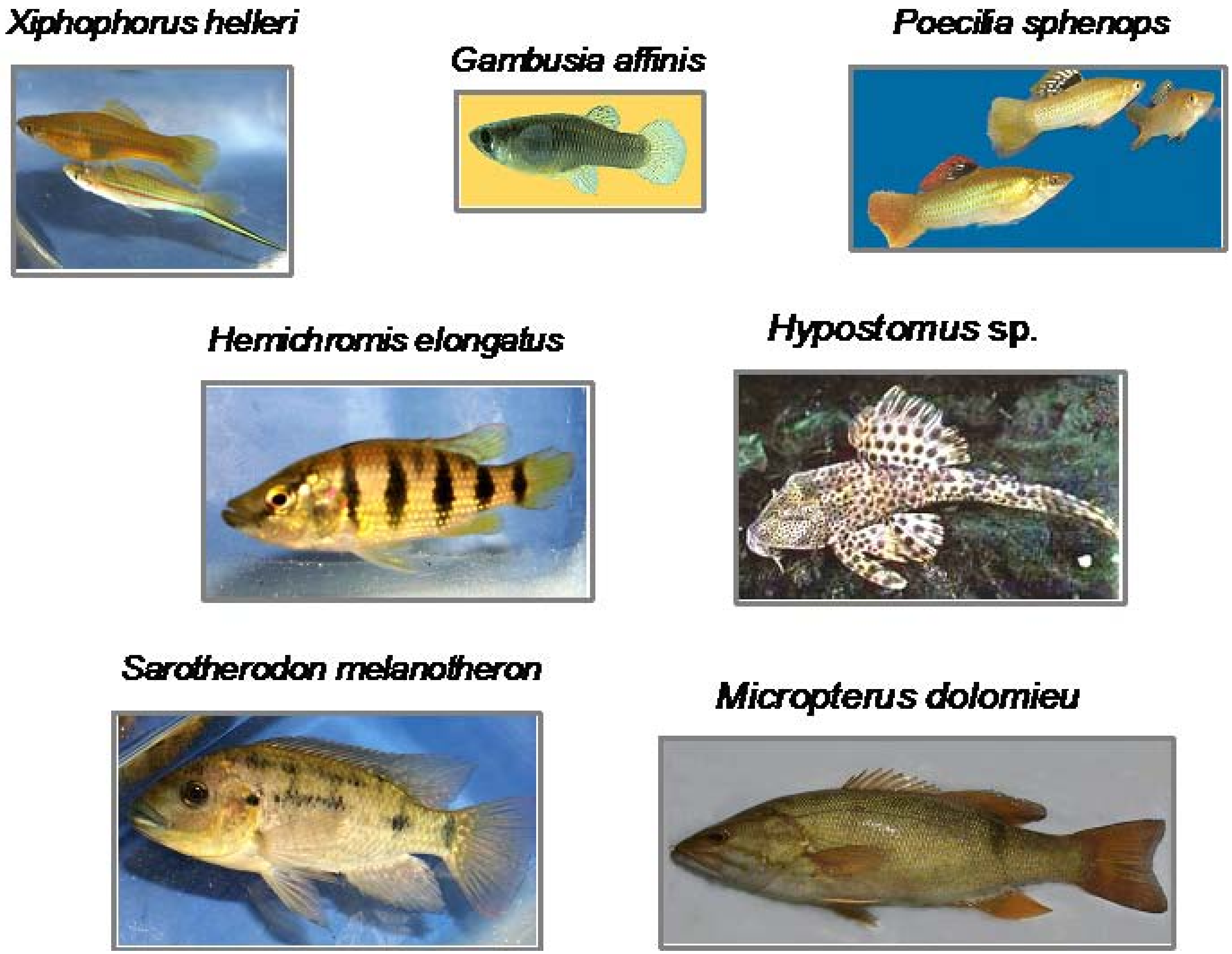


Figure A.4.1. Introduced stream species identification guide.

Appendix 5: Logistics and Aquatic Hitchhikers

This appendix includes logistical considerations and will be added to as logistical constraints arise or change. Fieldwork on Pacific Islands in remote locations can be logistically challenging and ample buffer time should be built in to field schedule to allow for unforeseen problems such as weather or transportation issues. This appendix also includes information on the prevention of transportation of introduced species (aquatic hitchhikers).

American Samoa

Travel to American Samoa

The initial point of entry to American Samoa is Pago Pago on the main island of Tutuila. Flights are only on Thursday and Sunday direct from Honolulu (HNL) to Pago Pago (PPG) exclusively on Hawaiian Airlines. A current passport is required for travel to American Samoa. American Samoa is -11:00 Greenwich Mean Time (GMT) or 1 hour earlier than Hawaiian Standard Time (HST). A water filter is highly recommended to filter drinking water especially on outer islands or during periods of heavy rainfall. Hotels and smaller lodges are easily available on Tutuila.

Transportation on Tutuila

Rental cars are available on Tutuila through Friendly rental car, Avis, and certain hotels. The I&M program currently shares ½ of a lease on a vehicle with the National Park of American Samoa, which can be made available to staff with advanced notice.

Directions to Tutuila Field Sites

Leafu stream is accessed by traveling the main road to Pago Pago and the road over the mountain to the village of Vatia. Note there are no official road names in American Samoa. Roads are distinguished by the villages they connect. Village chiefs and the mayor must be notified prior to arrival in the village. This should take place several days to preferably at least a week in advance. FTUT01 is accessed through a villager's backyard. Consult homeowners before sampling. It is helpful to have employees that speak Samoan assist in communication efforts. FTUT02 and FTUT03 are accessed by a trail that follows on the banks of the stream. Permission is needed from the mayor of the Vatia to access these sites. Again notification of the mayor in advance is required. Trail is marked with blue flagging tape.

Fagatutui Stream (FTUT04-FTUT06) is accessed by traveling the road from Pago Pago towards the village of Fagasa. Park at the Mount Alava trailhead, proceed up trail 2 miles until specified GPS point. Local staff know how to access these sites. It is helpful to have local knowledge. Trail is a very steep slope down and marked with pink flagging tape though there may be other trails in the area that can cause confusion. There are many streams in the area that look quite similar. It is extremely important to have accurate GPS coordinates when accessing the stream via trail. This stream can also be accessed via boat on days with calm sea conditions. The boat can is launched from the Fagasa boat ramp and driven 3 bays over to Fagatuitui Bay. Fagatuitui Bay is a distinctive looking bay with two streams that pour into the Bay. The sampled stream is the one on the right coming in from the ocean. Depending on sea conditions, crew capabilities, and boat specifications it may be possible to get relatively close to shore. However, it will be necessary to swim some distance to shore with all sampling gear. A float for the equipment will be required.

Amalau stream is accessed via the road from Pago Pago towards Vatia to the village of Amalau. Visitors must ask local villagers for permission to sample in Amalau stream. Permission should be obtained the day of, as well as several days in advance so they know to expect you. Site FTUT07 is at the mouth of the stream near the village fales. The site is accessed through private land. Remember to obtain permission. FTUT08 is easily accessed by walking upstream crossing highway and following stream until specified GPS point is reached.

In all travels to sites on Tutuila where village access is required, it is vitally important to recognize that you are traversing private land. When specific dates and times are established for sampling, these need to be honored. Local villagers get extremely upset when expected intrusions do not happen as planned. Also, following local customs is required. While sampling in village areas, dress must necessarily be modest and no work is to be conducted in village areas on Sundays. Contact park staff for any questions regarding local customs.

Travel to Tau

Flights to Tau are available on Inter Island Air based in Pago Pago Airport. It is advisable to contact local staff for assistance with booking flights to Tau. Flights can then be paid for, in person, at the local airport office at least one day prior to departure. Flights generally fly daily, however, they are extremely weather dependant and changeable at any moment. Call the Inter Island Air office the day before to determine exact flight time (varies depending on the day) and arrive at airport 2-3 hours ahead of scheduled flight time. It is not uncommon for the flight to leave early to try and beat the weather, or to leave several hours late. Be prepared to spend the entire day at the airport waiting for flights to happen. When flying with extra baggage, it is advisable (almost required) to arrive very early and secure a spot in the check in line. Luggage is taken on a first come first serve basis and no guarantees are made that excess luggage will make it on the flight. Additionally, if there is a village chief, talking chief, mayor, or local dignitary, their luggage will take priority over your luggage, regardless of order in line. Another option is to package gear ahead of time and ship it over beforehand via plane or boat (M/V Sili). Mauga Nofoaiga (park VIP) can receive packages in Tau. Contact local staff for assistance.

Housing on Tau

Homestays can be arranged through local NPSA staff. Generally, there are two options, Mele’s Place and Mauga’s Place. Mele’s place is set up more like a traditional hotel. Rooms are separate from the family’s living quarters. They offer basic, shared cooking facilities. Food should be brought over from Tutuila, though there is a small store on Tau, it has a very limited supply of options and is not regularly restocked. Mauga’s Place has 4 rooms and a kitchen/dining area that is shared by the family and guests. The family will prepare local style meals for an additional fee.

Camping is possible only in the lower portion of the Laufuti Stream or at the end of the access road at the beginning of the trail to Laufuti. Solid tents are essential as the mosquitoes in the area are vicious. Extra rope/parachute cord is necessary to tie down tents as stakes do not work well in sand. The best camping is on the sandy beach 15 minutes before you reach the stream.

Camping hammocks are unsuitable due to the mosquitoes. Camping in the upper portion of the stream is not possible due to the steep and heavily forested terrain. All camping gear (tents, water filter, sleeping bags, cooking gear) must be brought over from Tutuila; there are no supplies available on Tau. There is no camp fuel available on Tutuila. Fuel is not allowed on airplanes, therefore, fuel must be shipped over via boat well in advance. The M/V Sili is a cargo ship that makes sporadic trips to the outer islands. Contact local staff for boat schedule and to arrange cargo transport.

Directions to Tau field sites

All fixed field sites (FTAU01-FTAU04) are accessed via the beach trail at the end of the 4WD road. The trail leads over a short sandy beach, a boulder beach, and a relatively smooth forested trail. The trail then splits to access lower Laufuti and middle/upper Laufuti. Allow 30 minutes to trail junction. The trail down to lower Laufuti (FTAU01-FTAU02) is a steep, slippery slope that ends at a rocky beach. The trail was improved and a ladder installed in 2010 to assist hikers. Follow the coast along sandy and boulder beaches until the mouth of Laufuti stream. This takes approximately 2 hours from the split due to the rough terrain and heavy gear. To access the middle and upper sections of Laufuti (FTAU03-FTAU04), the trail follows the ridgeline up a steep climb. This trail can be extremely overgrown and may take extra time to cut through the vegetation with machetes. It is helpful to ask NPSA staff to cut the trail in advance. This saves hours of hacking through the jungle. Notify staff of intended arrival at least 2 months prior to facilitate trail clearing. The trail is flagged with blue and pink flagging tape though they may not be entirely visible if overgrown. The trail climbs through mostly fern forest. Many large boulders, exposed roots, moss covered lava rocks, and thick vegetation present hazards. Pants, long sleeve shirts, and mosquito repellant are essential. VIP Tuiluiga Simolea and NPSA Marine Technician Bert Fuiava know all field sites and access routes.

NPSA Park contacts 684-633-7082

Tim Clark, Marine Ecologist
Bert Fuiavia, Marine Technican
Jim Nimz, Marine Technician
Visa Vaivai, I&M Biological Science Technician

Guam

Travel to Guam

Daily flights are available on Continental and American Airlines to A.B. Wonpat International Airport (GUM). A passport is necessary. Guam is +10 hours GMT. It is over the International Dateline, therefore Guam is 1 day ahead and 4 hours behind Hawaii Standard Time. Rental cars are easily available on Guam from most major American companies. Park staff may be able to make a vehicle available if enough advanced notice is given (preferably 1-2 months). Most hotels are located in the Tumon and Taumuning areas of Guam, roughly a 20-30 minute drive from WAPA’s main office in Hagatna. It is also possible to rent an apartment in Guam for extended stays. Arrangements can be made through the park and require at least 2 months advanced notice.

Directions to field sites

All field sites are located on Asan stream in the Asan Unit of War in the Pacific National Park. From the Airport or Tumon take highway 10A to Marine Corps Drive (Guam Route 1). Turn left and go approximately 6 miles. Turn left onto Jose Leon Guerrero Street. Park on street near bridge over Asan stream. Access the lower sites by heading upstream in the river. The first fixed site is approximately 70 meters upstream from the parking location, just immediately past the overhanging vegetation on the stream. Heading upstream, there is a trail on the left stream bank (right side when facing upstream) just past the second banana plantation where there are several limestone rocks in the bend of the stream. This trail can be used to facilitate quicker access to central river sites up to the dam. All sites can be accessed by hiking upstream in the stream; however, this is recommended only for sites downstream of FWAPA02 (lower sites).

Middle stream sites can be accessed by turning left onto Guam Route 6 from Marine Corps Drive toward the Asan Unit Overlook. Turn left onto Mama Sandy Road toward a residential area. Turn onto the small dirt road labeled J Street. Follow this road over the hill and then take the first dirt road to the right (it is unmarked as of January 2011). Follow this dirt road downhill until you reach the lowest cleared lot (the road will turn left and then start heading uphill again). Park in this cleared lot. At the entrance to the cleared lot, you will find an overgrown access road. Follow this road along the ridge until it turns to the left. Don't turn left (This is an extremely important direction note). Continue hiking over the ridge in front of you (the main ridge). All middle stream sites can be accessed from points along the main ridge. If luck is on your side, you will find a hash/pig trail that runs along the top of the main ridge. Follow this trail along the main ridge and use your GPS to access all sites in the middle portion of the stream. The uppermost middle site, FWAPA06, can be accessed by crossing this main ridge from the access road and continuing to head down the side ridge to the stream. You will enter the stream about 100 meters downstream of the site (this is not the current preferred route as it is presently overgrown with sword-grass, but it is an access route, and the frequent fires may change the vegetation making it an excellent access point in the future). As you access the middle trail sites, remember to keep the main valley to your right. There are several side ridges, which, if taken, will lead you into sword-grass fields and wasp lairs, which are better avoided. All sites in the middle stream can be access by heading upstream from the previous location.

Upper sites can be accessed by turning left onto Guam Route 6 from Marine Corps Drive toward the Asan Unit Overlook. Then turn left onto Mama Sandy Road toward a residential area. Turn onto the small dirt road labeled J Street and park. Walk through the lower cleared lots to the furthermost corner of the second cleared lot. There is a short, 15 minute trail down to the stream. This trail goes directly to the uppermost fixed site on Asan stream, FWAPA16.

Park contacts 671-477-7278

Barbara Alberti, Park Superintendant
Mike Gawel, Chief of Resources

Maui

Travel to Maui

Flights are available on multiple airlines to Kahului International Airport (OGG). Rental cars are available from most major American companies at the airport.

Directions to Field Sites

All field sites are located in the Kipahulu area of Haleakala National Park. From OGG follow the Hana Hwy/HI-360 (Hana way or north route) to Kipahulu or follow Haleakala Hwy/HI-37 to Piilani Hwy/HI-31 (south route) to Kipahulu. It takes approximately 3 hours each way from the airport to Kipahulu.

FHALE01 is located near the mouth of the stream and is accessed via the Seven Sacred Pools trail from the Kipahulu visitor's center. FHALE07 is accessed by taking the 2 mile long Pipiwai trail then following the rarely used Makahiku Falls trail (marked only by an old sign). Cross the bridge, and follow trail to the stream. Cross the stream to the right bank and follow the stream to appointed GPS point. FHALE02, FHALE08, and FHALE03 are located just off the Pipiwai trail. FHALE02 is at the lower USGS gauging station. FHALE08 is accessed by hiking upstream in Pipiwai Stream just after the confluence of Palikea and Pipiwai. FHALE03 is at the base of Waimoku falls just upstream of where the trail crosses the stream. FHALE09 is accessed by hiking in the stream up Palikea just after the confluence of Palikea and Pipiwai. Temporary sites on Palikea or Pipiwai streams can be accessed via the Pipiwai trail.

FHALE05, FHALE06, and all temporary sites on Alelele are accessed by following highway 31 south from Kipahulu to the Alelele bridge. Park in the pullout near the mouth of the stream. Follow the trail on the left bank of the stream to access all sites.

Housing

Camping is available in the Kipahulu maintenance yard by prior arrangement. Contact Stephen Anderson or April Gragas for more information about camping reservations. There is a small communal cabin that is used for cooking. There is a propane stove, refrigerator, tables, and chairs. Bring all food, cookware, and dishes from Kahului. There is a small store in Hana if additional supplies are necessary (40 minutes north of Kipahulu). Bring adequate drinking water or a filter as no potable water is available in Kipahulu. There is catchment water that can be boiled for cooking, filtered, and used to wash dishes. This cabin is shared by all employees camping in Kipahulu. Ample tent space is available just outside the cabin. Bring all camping gear. It rains regularly in Kipahulu.

Park contacts

Stephen Anderson, Natural Resource Program Manager, 808-572-4480
Sarah Creachbaum, Superindentant, 808-572-4401
April Gragas, Adminstrative Assistant, 808-572-4432

Molokai

Travel to Kalaupapa

There are two options for travel to Kalaupapa. There are regular flights to Hoolehua Airport (MKK) located topside Molokai. It is then possible to take a cab to the trailhead down to Kalaupapa and hike 3 miles down the Pali Trail to the settlement. The trail is very steep with numerous switchbacks. The hike down is about 45 minutes while the hike up is 1-1 ½ hours. This requires preplanning by shipping gear 2 weeks in advance (Fedex 2 day takes 5-7 working days to reach Kalaupapa). The other option is to fly directly to Kalaupapa airport (LUP) on Pacific Wings. This is significantly more expensive, but less hassle as you can carry equipment as baggage. In either case, at least 2 weeks advance notice is required to enter Kalaupapa. Contact local staff for more information. All guests must be sponsored by local staff and escorted from the airport or the trailhead. Lodging in the settlement must also be prearranged with local staff.

Travel to Field Sites

All field sites are located on Waikolu Stream. There are 3 access options. The first is to hike from Kalawao (20 minute drive from main Kalaupapa settlement) down to the boulder beach and across to Waikolu. The trail follows the coast alongside steep sea cliffs. Hardhats are required. The hike is not advised during periods of heavy rain as this can cause loose rocks to fall from cliffs. The hike is approximately 1.5 miles over a boulder beach with loose and slippery rocks. The hike takes 1-1 ½ hours depending on pack weight and weather conditions. The 2nd option is boat from the settlement around the point to Waikolu. This requires extensive planning with local staff and calm sea conditions. The drive is approximately 45 minutes. Launching and loading the boat takes approximately 1 hour. The boat can be anchored in the bay for near shore gear unloading. Gear unloading takes approximately 1 hour. Camping is possible at the mouth of the stream with proper permission. The 3rd option is to drive through the water diversion tunnel from topside. This allows easier access to sites above the pumphouse. Prior permission must be obtained through the Molokai Irrigation System part of the Department of Agriculture. A 4WD vehicle that meets the tunnels specifications must be obtained. Jeep Wranglers that meet these specifications are available for rent through Island Kine Rental Car (808-553-5242) located in Kaunakakai. Arrangements with workers must be made for directions to the tunnel and to borrow keys to access the tunnel. Contact Oscar Ignacio at 808-336-0587 for tunnel access. The drive takes approximately 2 ½ hours from Kaunakakai.

Once in Waikolu Valley, all sites below the tunnel can be accessed by hiking up the stream or from the trail. The trail goes from the mouth of the river to the pumphouse, and continues as a road to the tunnel. All sights above the tunnel must be accessed by taking the catwalk that goes from the tunnel to the diversion dam, and then hiking up stream. Sites near the tunnel and waterfalls can be accessed by taking the catwalk that crosses the valley to the collection pool at the base of the waterfalls, and then scrambling down to the stream below. The main trail along Waikolu stream starts on the left Bank of the lefter most branch of the stream (the extreme right of the valley facing upstream). Hike to the rocks that form the valley wall and begin walking upstream. This trail is unmarked in this location so some faith must be taken the trail is there. You will be touching the cliff as you hike the initial several meters of the trail. The trail then becomes somewhat more distinct and travels along both sides of the stream crossing in several places. GPS is useful in locating sites, but not always accurate or dependable as the signal gets degraded the further upstream you travel. Navigation by topographic maps is advisable, and at times required to locate the sites.

Housing Kalaupapa

Housing in settlement is available by prearrangement with local staff. Camping is possible in Waikolu Valley with prior permission from the patient's council. Camping is also possible near the pumphouse about halfway up the stream. All camping gear including water filter, stoves, tents, sleeping bags must be brought in. All travel to this stream must be arranged in advance (preferable 1-2 months) to allow time for all proper permissions to be obtained.

Park contacts 808-567-6802

Eric Brown, Marine Ecologist ex 1502
Kim Tice, Inventory & Monitoring Biological Science Technician ex 1510

General Prevention Procedures for Stopping Aquatic Hitchhikers: *methods for preventing the transporation of non-native (introduced) species*.

Follow a general set of procedures every time you come in contact with any body of water. By doing so, you can protect your waters from harmful aquatic hitchhikers. Because you never know where a nuisance species has been introduced, but has yet to be discovered.

Remove all visible mud, plants, fish/animals.
Before leaving any body of water, it is important to examine all your equipment, boats, trailers, clothing, boots, buckets etc and:

- Remove any visible plants, fish or animals.
- Remove mud and dirt since it too may contain a hitchhiker.*
- Remove even plant fragments as they may contain a hitchhiker.*
- Do not transport any potential hitchhiker, even back to your home. Remove and leave them at the site you visited.

*The larvae (immature form) of an animal can be so tiny that you cannot see it. However, it can live in mud, dirt, sand, and on plant fragments.

Eliminate water from all equipment before transporting anywhere.
Much of the recreational equipment used in water contains many spots where water can collect and potentially harbor these aquatic hitchhikers. Thus, make sure that you:

- Eliminate all water from every conceivable item before you leave the area you are visiting.
- Remove water from motors, jet drives, live wells, boat hulls, scuba tanks and regulators, boots, waders, bait buckets, seaplane floats, swimming floats.
- Once water is eliminated, follow the cleaning instructions listed below.

Clean and dry anything that came in contact with the water.
(boats, trailers, equipment, dogs, boots, clothing, etc.). Basic procedures include:

- Use hot (< 40° C or 104° F) or salt water to clean your equipment.
- In some instances you may use a dilute clorox bath, if that is what is available. 2 cups of chlorox in five gallons of water can be put in a cooler or rubbermaid container, and equipment dipped in that.
- The following recipes are recommended for cleaning hard-to-treat equipment that cannot be exposed to hot water:
    - Dipping equipment into 100% vinegar for 20 minutes will kill harmful aquatic hitchhiker species.
    - A 1 % table salt solution for 24 hours can replace the vinegar dip. This table provides correct mixtures for the 1 % salt solution in water:

Gallons of Water	Cups of Salt
5	2/3
10	1 ¼
25	3
50	6 1/4
100	12 2/3

- If hot water is not available, **spray** equipment such as boats, motors, trailers, anchors, decoys, floats, nets, **with high-pressure water.**
- **DRY Equipment.** If possible, allow for 5 days of drying time before entering new waters.

Figure A.5.1. General Prevention Procedures for Stopping Aquatic Hitchhikers: methods for preventing the transporation of non-native (introduced) species.

There are hundreds of different harmful species ranging from plants, fish, amphibians, crustaceans, mollusks, diseases or pathogens. Some organisms are so small, you may not even realize they are hitching a ride with you. So, it is important to follow this general procedure every time you leave any body of water.

It is recommended that the field crews use a separate set of equipment (including personal gear such as boots) for each island group (Hawaii, Guam, and American Samoa). Regardless, all gear should be cleaned at the end of a sampling event and before moving to a new site**.**

Prevention, where possible

- Avoid dumping water directly from one stream or lake into another.
- Avoid obtaining water from multiple sources during a single operational period unless drafting/dipping equipment is sanitized between sources.
- Minimize driving equipment through water bodies.

Sanitation

- Set up a portable disinfection tank using a 5% cleaning solution of quaternary ammonium compound – common cleaning agents used in homes, swimming pools, and hospitals that are safe for gear and equipment when used at the recommended concentration. Two brands are readily available from GSA or local suppliers: *Quat128®* (by Waxie) or *Sparquat 256®* (by Spartan). Costs and effectiveness are comparable; use either.

Table A.5.1. Recipe for 5% cleaning solution using either *Quat128®* *or* *Sparquat 256®*

Volume of tap water	Volume of *Quat128®*	Volume of *Sparquat 256®*
100 mL water	4.63 mL	3.00 mL
1 gallon water	6.35 liquid oz.	4.12 liquid oz.
1 gallon water	12.7 tbsp	8.2 tbsp
1 gallon water	0.79 cups	0.51 cups
100 gallons water	4.96 gallons	3.22 gallons
1000 gallons water	49.6 gallons	32.2 gallons

- Where feasible dip gear or equipment (e.g. helicopter buckets) into the cleaning solution. Alternatively, put the 5% cleaning solution in backpack spray pumps to clean portable equipment. The solution must be in contact with the surface being sanitized for at least 10 minutes and then rinsed with water.
- Under the direction of the Resource Advisor, test cleaning solution at least daily according to the directions below. The cleaning solution can be used repeatedly for up to a week unless heavily muddied or diluted. If the concentration is too weak, dispose of the used solution properly and make a new solution.

Safety

- Use protective, unlined rubber gloves and splash goggles or face shield when handling the cleaning solution and take extra precautions when handling undiluted chemicals. Have eye wash and clean water available on-site to treat accidental exposure.

- Consult the product label and Material Safety Data Sheet for additional information.

Testing Solution

- To determine if the solution is below the 5% strength use "Quat Chek 1000" Test Papers (purchase these from the supplier of the cleaning compound). The used cleaning solution needs to be diluted to about 600 ppm of ammonium compounds before it can be tested with these papers.
    - Take **one** cup of used *Sparquat 256*® cleaning solution, pour into a bucket. Add **5** cups of water. Mix. <u>OR</u>
    - Take **one** cup of used *Quat128*® cleaning solution, pour into a bucket. Add **4** cups of water. Mix.
- Test the diluted solution with "Quat Chek" Test Paper. Match up the color of the paper with the ppm's on the color chart. For optimal disinfection, the diluted solution should have a concentration between 600 and 800 ppm. If it is too dilute, dispose of properly and make a new cleaning solution.

Disposal

- Do not dump cleaning solution into any stream or lake, or on areas where it can migrate into any stormdrain, waterbody, or sensitive habitat. It may be possible to dispose of used cleaning solution over open land. Consult Resource Advisor before using this method.
- Depending on volume, used cleaning solution may be disposed of by trucking off-site for disposal in a wastewater treatment facility..
- Used cleaning solution may or may not be suitable for disposal in on-site septic systems. Consult the local agency's Utilities Supervisor or Facilities Manager prior to disposal.

Storage

Sparquat 256® and *Quat128*® can be stored up to two years in an unopened container without losing its effectiveness. Both should be stored in a cool, dry place, out of direct sunlight. Temperatures can range from 32º to 110º F.

Purchase

Both products are available from GSA (https://www.gsaadvantage.gov) and are commonly available through local janitorial and swimming pool chemical suppliers.

- *Quat 128*® by Waxie's Enterprises Inc.; GSA (NSN No. 170304) =$36/case (4 gal); Additional info can be found at http://www.waxie.com
- *Sparquat 256*® by Spartan Chemical Company; GSA (NSN No. 1025-04) = $54/case (4 gal); Additional info can be found at http://www.spartanchemical.com
- Remember to buy "Quat Chek 1000" test papers when you purchase the chemicals.

Appendix 6: Additional statistical analyses and power estimates for preliminary sample size determination

Parametric statistical power estimations using equations developed for the Pacific Island Inventory and Monitoring Network (Skalski 2005), yield further information about the ability to detect trends over time. These preliminary analyses are presented here as examples to guide analyses of sample size determination and sampling strategies once several more years of data have been collected on Molokai, and for sites where no preliminary data was available. The Skalski power equations allow for changing variability over time, calculating power by using a mean of the variances for each monitoring event, and a corresponding mean of the means. This is distinguished from the ability to detect a difference in means such as a t-test would detect, in that a trend estimates continuing small changes in mean over time, as opposed to specific differences between two means.

Based on the results (Table A.6.1), it would initially appear that the ability to detect trend over time has a relatively low power. It is important to note that this is a parametric method of detecting trend with significant limitation resulting from the relatively small data set (2 years), subsequently resulting in a relatively large population variability among sample dates, decreasing calculated power. Based on these calculations, this protocol has a 34% chance of detecting a 50% change in *Alamo'o* population means for Waikolu stream with 95% confidence based on the current variability. However, changes in population may very likely bring about changes in variability and increased samples from which to perform analyses should reduce variability. Both changes should cause power to correspondingly increase. Due to the small data set, these analyses were deemed currently inappropriate to base the power to detect change portion of the monitoring protocol on and the other analyses were used as a more accurate measure of power (described in the narrative). Nevertheless, the Skalski equations should be re-evaluated for relevancy in future years.

Table A.6.1. 25 year extrapolated results from two years of quarterly data collected in Waikolu stream on the island of Molokai in Kalaupapa National Historical Park.

Power Output Comparison of Stream Analysis vs. Station Analysis (25 yr)							
		Whole Stream Analysis			Stream Analysis by Station		
	50% Change Value	**Nakea**	**Nopili**	**Alamo'o**	**Nakea**	**Nopili**	**Alamo'o**
Quarterly Sampling	α=0.05	0.105	0.127	0.143	0.091	0.153	0.159
	α=0.10	0.207	0.236	0.257	0.181	0.270	0.277
Annual Sampling	α=0.05	0.103	0.179	0.174	0.101	0.220	0.214
	α=0.10	0.200	0.300	0.295	0.198	0.347	0.343

This analysis was done to determine how frequently to conduct sampling surveys, and to determine whether statistical analyses should be based on individual stations, or a composite of data from all the sampling stations. From a biological standpoint annual sampling with a station by station analysis makes the most sense intuitively as different species of fish occupy different sections and reaches of the stream, i.e. *Nakea* tends to be in lower reaches in pools while

Alamo'o tends to be further upstream. Analyzing on a whole stream basis would aggregate reaches not occupied by the fish and therefore increase variability.

The analysis indicates that for two of the fish species (*Nopili* and *Alamo'o*), the station by station analysis is more effective and for one of the species (*Nakea*) the stream analysis was more effective. When comparing the difference between the increase in power to detect change based on a whole stream analysis vs. a station by station analysis (Table A.6.2) the station by station analysis generally gives a higher increase in power over the whole stream analysis with the notable exception of *Alamo'o* vs. *Nakea* in quarterly sampling at α=0.10 (-2.0% vs. 2.6%). These results would then indicate that when doing a population analysis to detect trends in abundance, a station by station analysis of the individual species would be the appropriate analysis to begin with, followed by a whole stream analysis of selected species.

Table A.6.2. Differences of the whole stream sampling power output vs. the station by station power output. Negative percentages indicate percentages favoring station by station comparisons and positive percentages indicate percentages favoring whole stream analysis.

Power Output Comparison of Stream Analysis vs. Station Analysis (25 yr)				
	50% Change Value	**Nakea**	**Nopili**	**Alamo'o**
Quarterly Sampling	α=0.05	1.363%	-2.575%	-1.519%
	α=0.10	2.587%	-3.356%	-1.964%
Annual Sampling	α=0.05	0.127%	-4.032%	-3.950%
	α=0.10	0.250%	-4.695%	-4.799%

A trend analysis was run using quarterly and annual sampling regimes to evaluate the frequency of sampling events. The annual sampling was compared August of 1993 to August of 1994 which correlates to the dry season and low flow stream conditions. The quarterly sampling compared all 4 sampling dates within each year (8 total sampling time periods). The results (Table A.6.1) were then compared to each other (Table A.6.3) to determine which method would yield the greatest power to detect trends in population changes. With the notable exception of *Nakea* using whole stream analysis methods, all comparisons indicate that annual sampling yields higher power to detect change than quarterly sampling would produce. These results support an annual sampling frequency. The complete results of the analysis are presented in Table A.6.4.

Table A.6.3. Differences of quarterly sampling vs. annual sampling power to detect trends in population changes. Negative percentages favor quarterly sampling and positive percentages favor annual sampling.

Power Output Difference Comparison of Annual vs. Quarterly Sampling (25 yr)							
		Whole Stream Analysis			Stream Analysis by Station		
	50% Change Value	**Nakea**	**Nopili**	**Alamo'o**	**Nakea**	**Nopili**	**Alamo'o**
Annual	α=0.05	-0.25%	5.21%	3.09%	0.99%	6.66%	5.52%
Quarterly	α=0.10	-0.67%	6.36%	3.73%	1.67%	7.70%	6.56%

Table A.6.4. Power output results of the Skalski Trend Analysis on the data set collected by Anne Brasher in 1993 – 1994 in Waikolu Stream in Kalaupapa National Historical Park on the Island of Molokai, Hawaii. Headings in yellow indicate power outputs based on whole stream analysis and headings in blue indicate station by station analysis.

Stream Power Output *Nakea* all dates					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.013	0.016	0.020	0.022	0.025
25%	0.032	0.041	0.049	0.055	0.061
50%	0.064	0.082	0.098	0.104	**0.105**
α=0.10					
10%	0.025	0.033	0.039	0.044	0.049
25%	0.064	0.082	0.097	0.110	0.122
50%	0.127	0.163	0.193	0.205	**0.207**

Power Output *Nakea* Aug					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.010	0.012	0.015	0.016	0.018
25%	0.024	0.031	0.036	0.041	0.046
50%	0.048	0.061	0.073	0.082	**0.091**
α=0.10					
10%	0.019	0.024	0.029	0.033	0.036
25%	0.047	0.061	0.072	0.082	0.090
50%	0.095	0.121	0.144	0.163	**0.181**

Mean Station Power Output *Nakea* all dates					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.015	0.019	0.023	0.026	0.029
25%	0.037	0.048	0.056	0.062	0.068
50%	0.070	0.082	0.091	0.098	**0.103**
α=0.10					
10%	0.030	0.038	0.045	0.051	0.056
25%	0.074	0.095	0.111	0.123	0.134
50%	0.139	0.162	0.178	0.191	**0.200**

Mean Station Power Output *Nakea* Aug					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.015	0.019	0.022	0.025	0.028
25%	0.037	0.047	0.055	0.061	0.066
50%	0.068	0.080	0.089	0.096	**0.101**
α=0.10					
10%	0.029	0.037	0.044	0.050	0.056
25%	0.073	0.093	0.110	0.122	0.131
50%	0.135	0.159	0.176	0.188	**0.198**

Power Output *Nopili* all dates					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.031	0.040	0.048	0.054	0.060
25%	0.078	0.101	0.104	0.106	0.108
50%	0.106	0.111	0.117	0.122	**0.127**
α=0.10					
10%	0.062	0.080	0.095	0.107	0.119
25%	0.156	0.199	0.206	0.208	0.210
50%	0.209	0.216	0.223	0.230	**0.236**

Power Output *Nopili* Aug					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.044	0.056	0.067	0.076	0.084
25%	0.103	0.106	0.109	0.111	0.113
50%	0.110	0.122	0.132	0.143	**0.153**
α=0.10					
10%	0.087	0.112	0.133	0.151	0.167
25%	0.204	0.208	0.212	0.215	0.218
50%	0.216	0.231	0.244	0.258	**0.270**

Mean Station Power Output *Nopili* all dates					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.049	0.062	0.071	0.077	0.080
25%	0.085	0.095	0.103	0.109	0.114
50%	0.109	0.129	0.146	0.163	**0.179**
α=0.10					
10%	0.097	0.123	0.140	0.151	0.157
25%	0.168	0.185	0.198	0.207	0.215
50%	0.212	0.238	0.260	0.281	**0.300**

Mean Station Power Output *Nopili* Aug					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.059	0.073	0.081	0.086	0.090
25%	0.097	0.107	0.115	0.122	0.128
50%	0.120	0.149	0.173	0.197	**0.220**
α=0.10					
10%	0.118	0.144	0.160	0.169	0.176
25%	0.191	0.206	0.217	0.226	0.235
50%	0.229	0.265	0.294	0.322	**0.347**

Power Output *Alamo'o* all dates					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.039	0.051	0.060	0.068	0.076
25%	0.099	0.105	0.107	0.109	0.111
50%	0.108	0.118	0.126	0.135	**0.143**
α=0.10					
10%	0.079	0.101	0.119	0.135	0.150
25%	0.196	0.207	0.210	0.213	0.215
50%	0.213	0.225	0.235	0.247	**0.257**

Power Output *Alamo'o* Aug					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.046	0.059	0.070	0.080	0.088
25%	0.103	0.107	0.109	0.112	0.115
50%	0.111	0.124	0.136	0.147	**0.159**
α=0.10					
10%	0.092	0.117	0.139	0.158	0.175
25%	0.205	0.209	0.213	0.216	0.220
50%	0.217	0.233	0.248	0.263	**0.277**

Mean Station Power Output *Alamo'o* all dates					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.049	0.063	0.073	0.081	0.087
25%	0.093	0.100	0.104	0.109	0.114
50%	0.109	0.127	0.143	0.159	**0.174**
α=0.10					
10%	0.098	0.124	0.144	0.160	0.171
25%	0.185	0.195	0.201	0.208	0.214
50%	0.211	0.235	0.256	0.276	**0.295**

Mean Station Power Output *Alamo'o* Aug					
	Relative Change				
α=0.05	***5 yrs***	***10 yrs***	***15 yrs***	***20 yrs***	***25 yrs***
10%	0.061	0.076	0.085	0.092	0.096
25%	0.102	0.111	0.117	0.123	0.129
50%	0.122	0.147	0.170	0.192	**0.214**
α=0.10					
10%	0.122	0.151	0.169	0.181	0.188
25%	0.202	0.214	0.222	0.231	0.238
50%	0.233	0.265	0.292	0.318	**0.343**

References:

Skalski, J.R. 2005. Long-term monitoring: Basic study designs, estimators, and precision and power calculations., National Park Service Pacific Island Network Inventory and Monitoring Program Unpublished Report, Hawaii National Park, Hawaii, USA.

Appendix 7: Fixed Sampling sites (maps and coordinates)

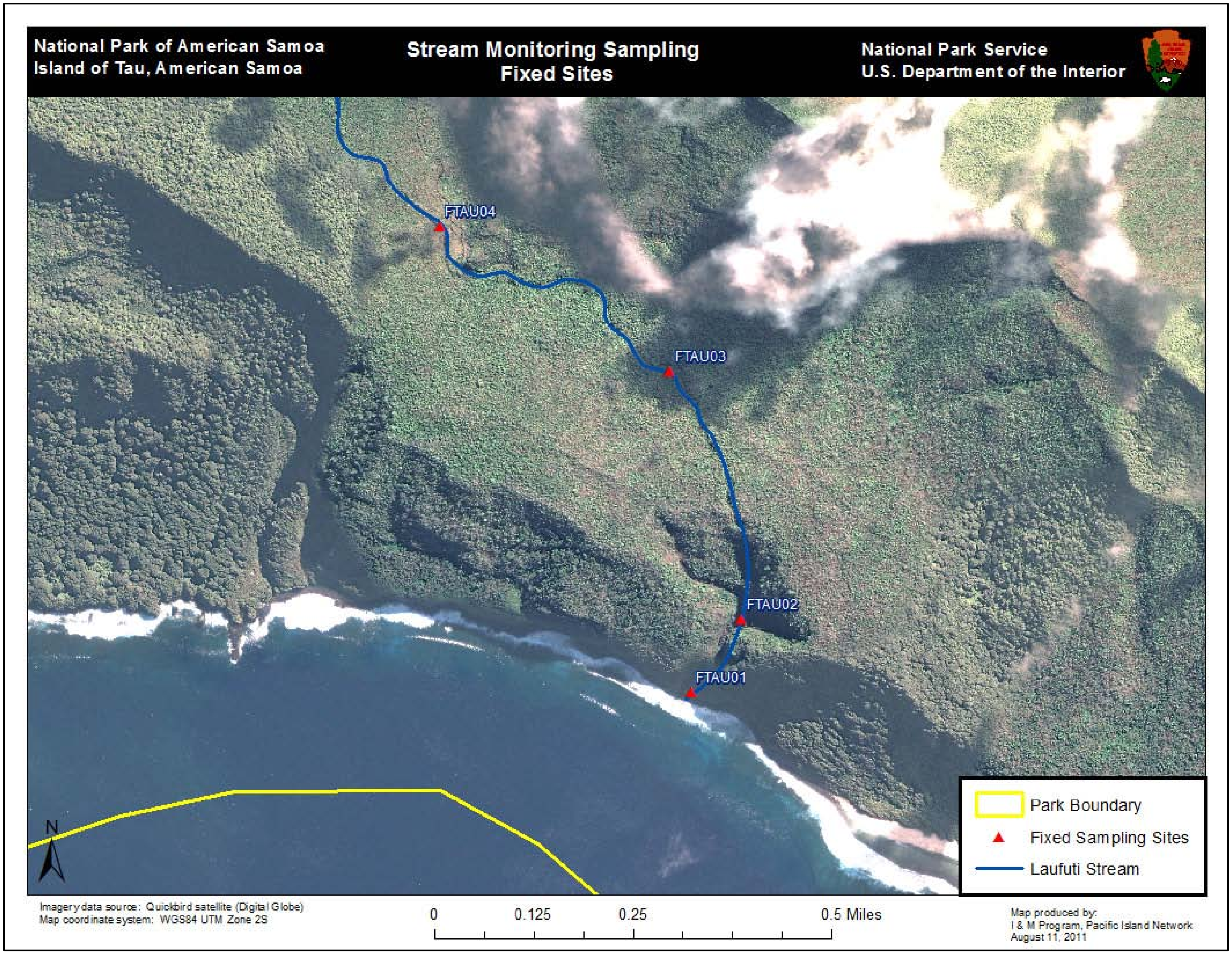


Figure A.7.1. National Park of American Samoa stream monitoring sampling fixed sites on Tau.

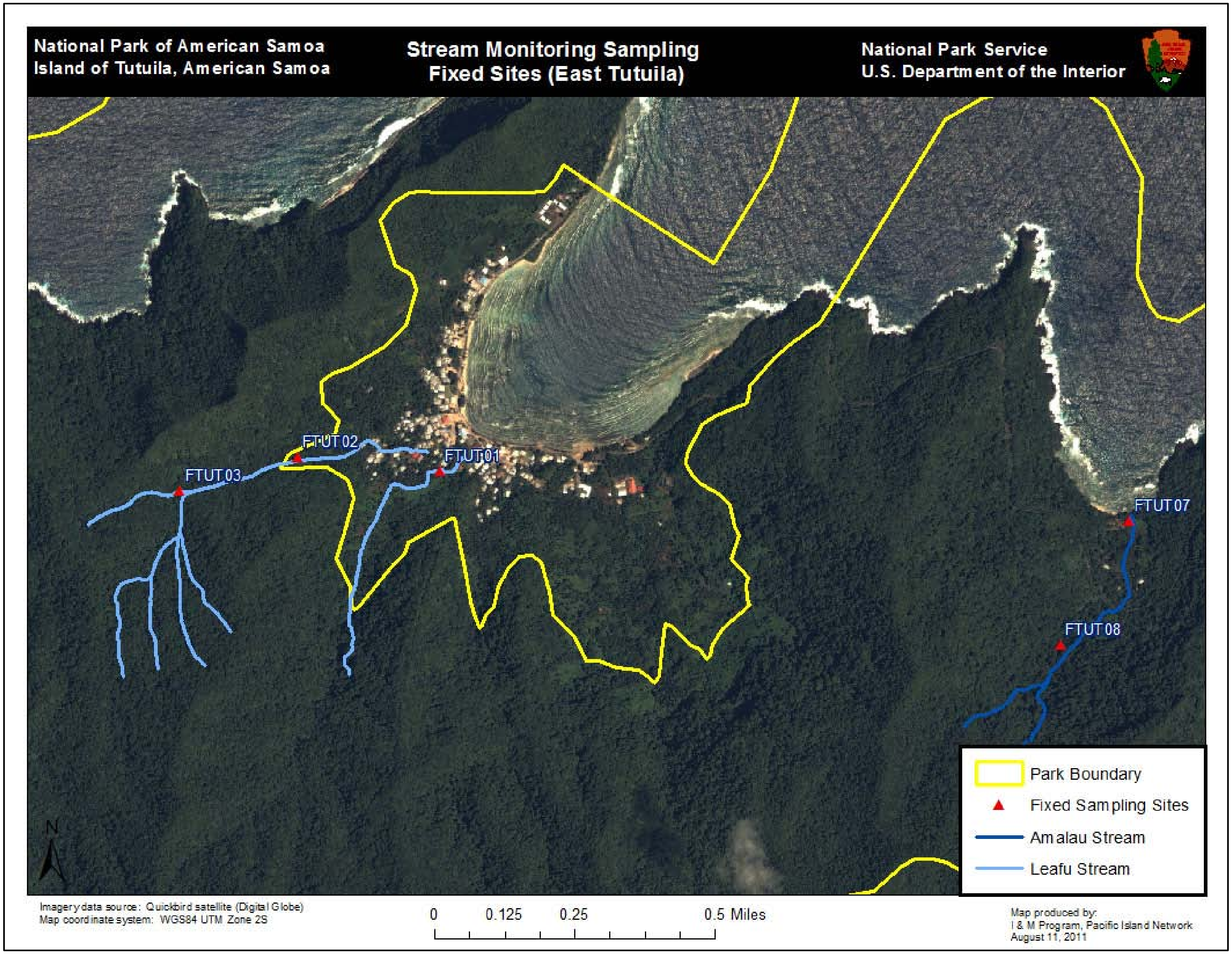


Figure A.7.2. National Park of American Samoa stream monitoring sampling fixed sites for eastern Tutuila.

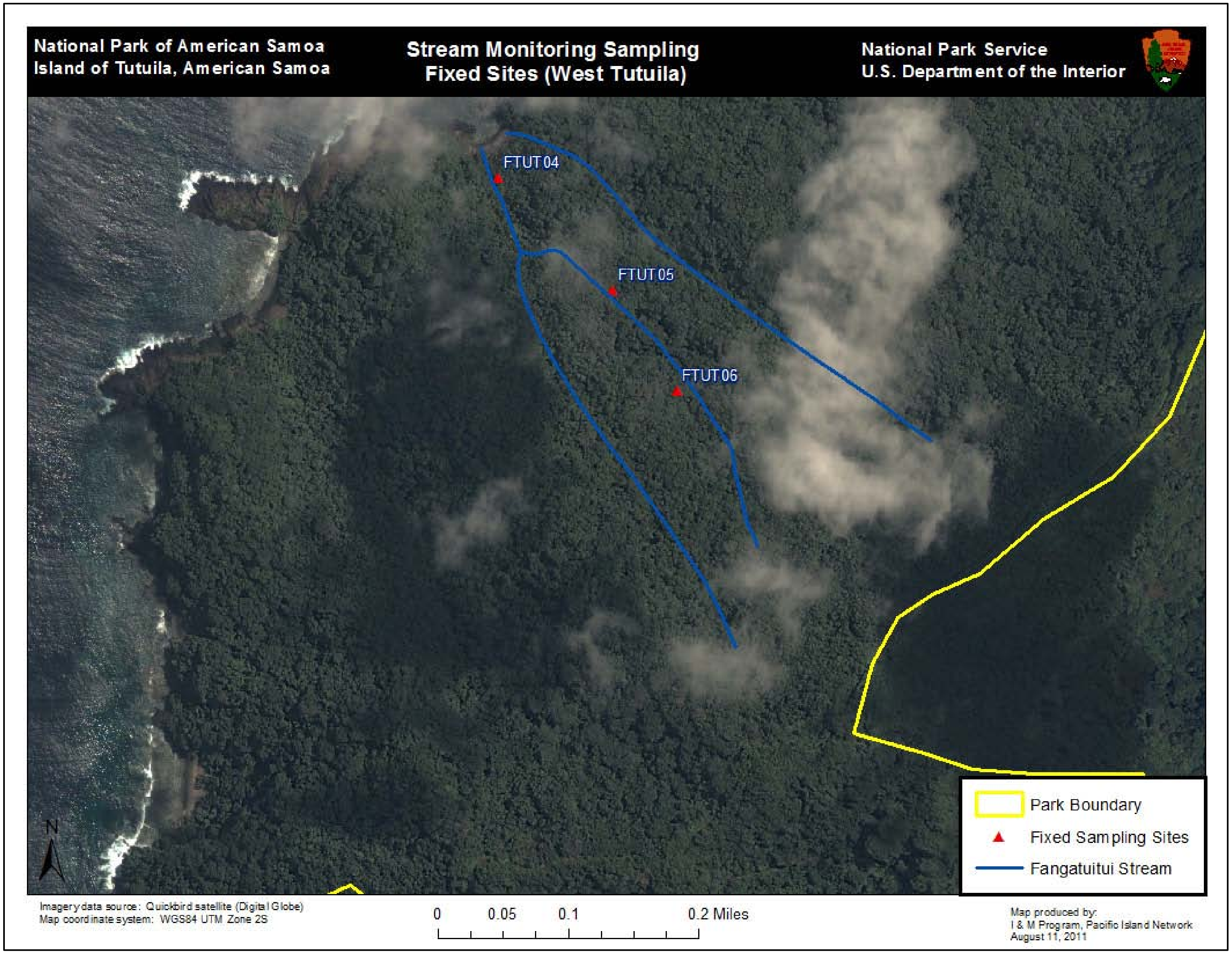


Figure A.7.3. National Park of American Samoa stream monitoring sampling fixed sites for western Tutuila.

Table A.7.1. Stream monitoring sampling fixed sites for National Park of American Samoa.

Stream Name	Sampling Site	Easting	Northing	Datum
Laufuti	FTAU01	-14.249783	-169.446147	WGS84
Laufuti	FTAU02	-14.248405	-169.445216	WGS84
Laufuti	FTAU03	-14.243942	-169.446533	WGS84
Laufuti	FTAU04	-14.241296	-169.450716	WGS84
Leafu	FTUT01	-14.25173	-170.676063	WGS84
Leafu	FTUT02	-14.251391	-170.679734	WGS84
Leafu	FTUT03	-14.252227	-170.682755	WGS84
Fangatuitui	FTUT04	-14.27248	-170.71915	WGS84
Fangatuitui	FTUT05	-14.273727	-170.717871	WGS84
Fangatuitui	FTUT06	-14.274838	-170.717156	WGS84
Amalau	FTUT07	-14.25301	-170.6583	WGS84
Amalau	FTUT08	-14.256213	-170.660067	WGS84

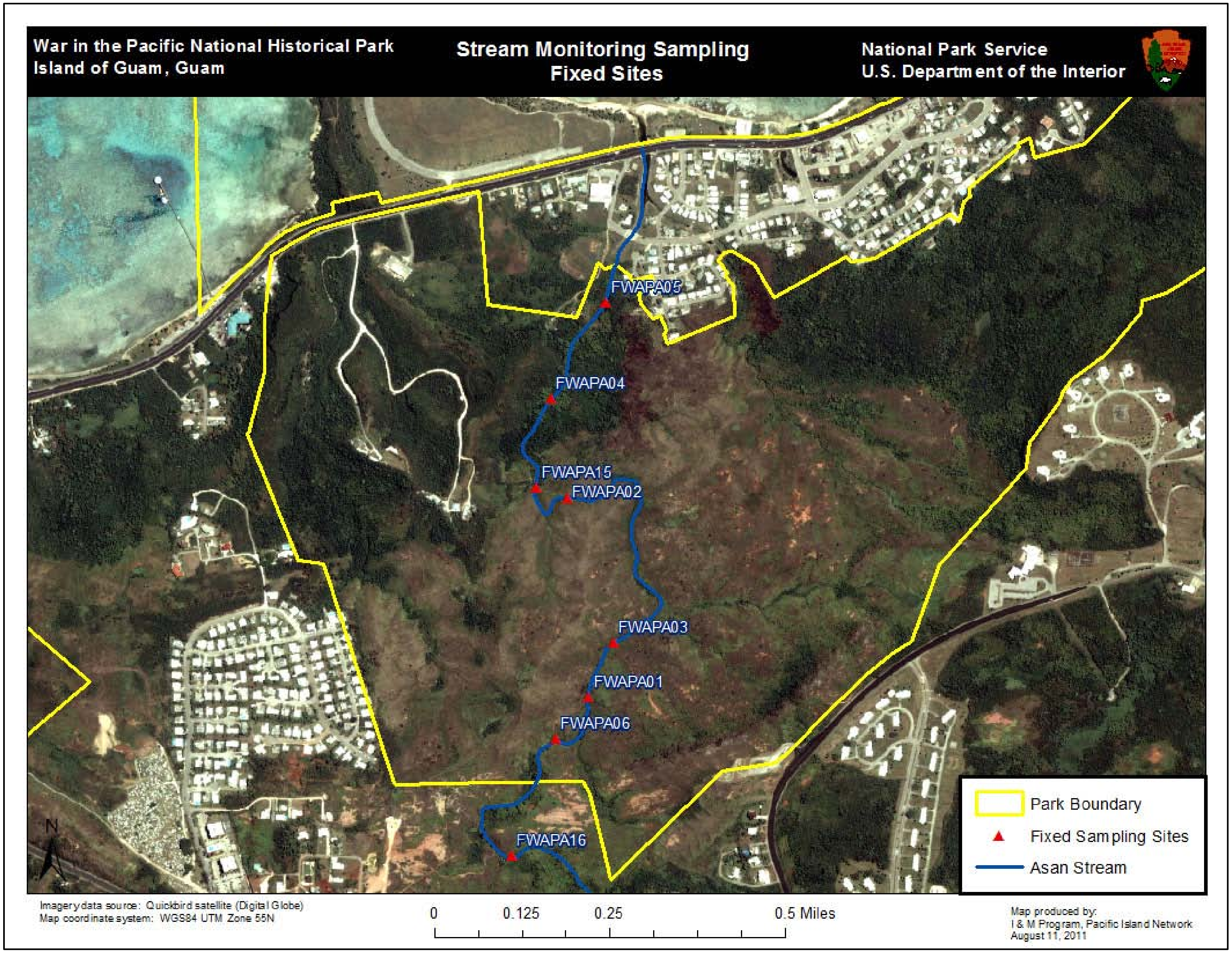


Figure A.7.4. War in the Pacific National Historical Park stream monitoring sampling fixed sites.

Table A.7.2. Stream monitoring sampling fixed sites for War in the Pacific National Historical Park.

Stream Name	Sampling Site	Easting	Northing	Datum
Asan	FWAPA01	13.46154	144.712392	WGS84
Asan	FWAPA02	13.465656	144.711946	WGS84
Asan	FWAPA03	13.462656	144.712898	WGS84
Asan	FWAPA04	13.467695	144.711613	WGS84
Asan	FWAPA05	13.469684	144.712748	WGS84
Asan	FWAPA06	13.460675	144.711708	WGS84
Asan	FWAPA15	13.465867	144.711317	WGS84
Asan	FWAPA16	13.458263	144.710807	WGS84

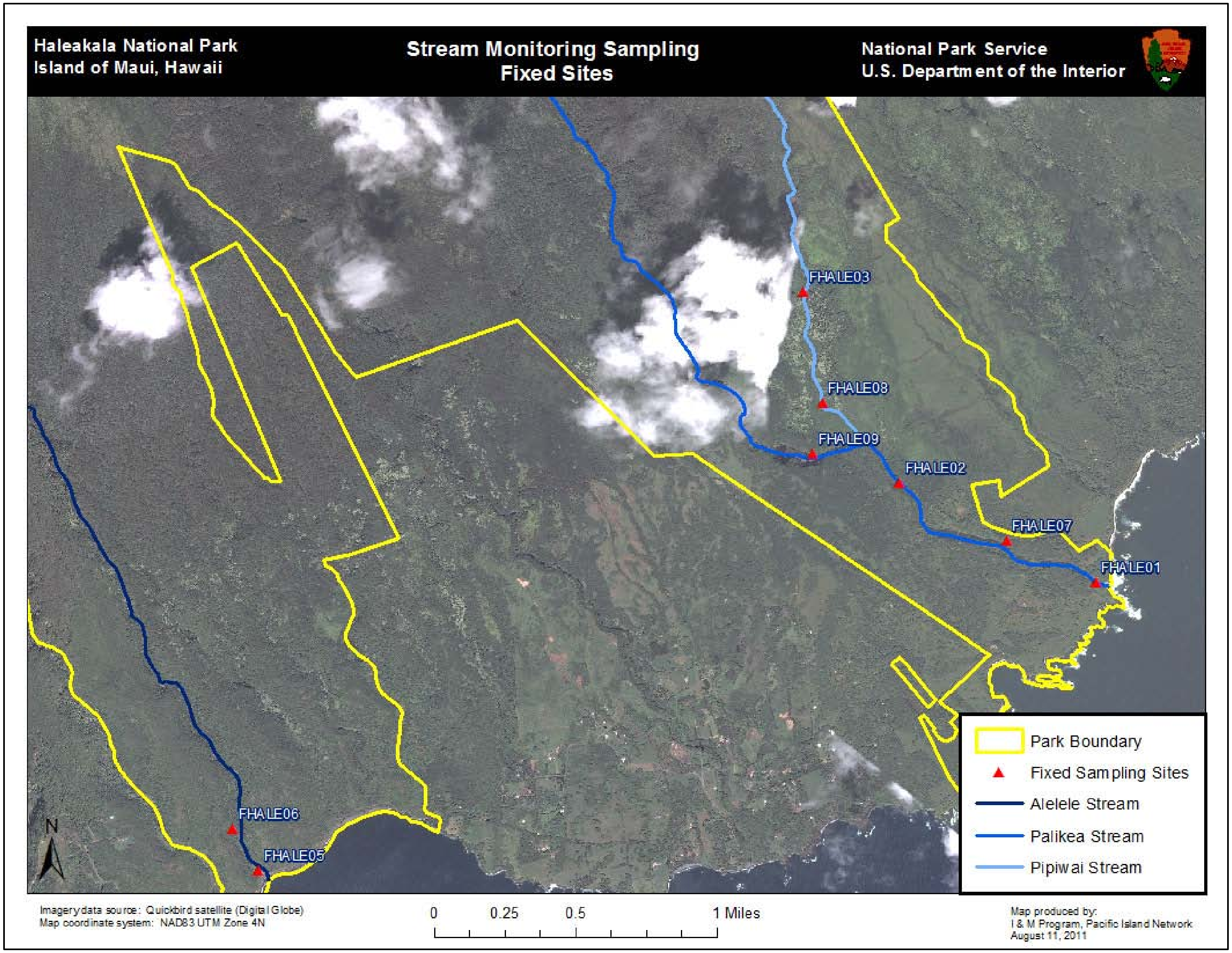


Figure A.7.5. Haleakala National Park stream monitoring sampling fixed sites.

Table A.7.3. Stream monitoring sampling fixed sites for Haleakala National Park.

Stream Name	Sampling Site	Easting	Northing	Datum
Pipiwai	FHALE01	20.662974	-156.041852	WGS84
Palikea	FHALE02	20.66807714	-156.0519163	WGS84
Pipiwai	FHALE03	20.677879	-156.056814	WGS84
Alelele	FHALE05	20.648204	-156.084768	WGS84
Alelele	FHALE06	20.65035042	-156.0860841	WGS84
Pipiwai	FHALE07	20.66514633	-156.0464213	WGS84
Pipiwai	FHALE08	20.67218713	-156.0558619	WGS84
Palikea	FHALE09	20.66954272	-156.056356	WGS84

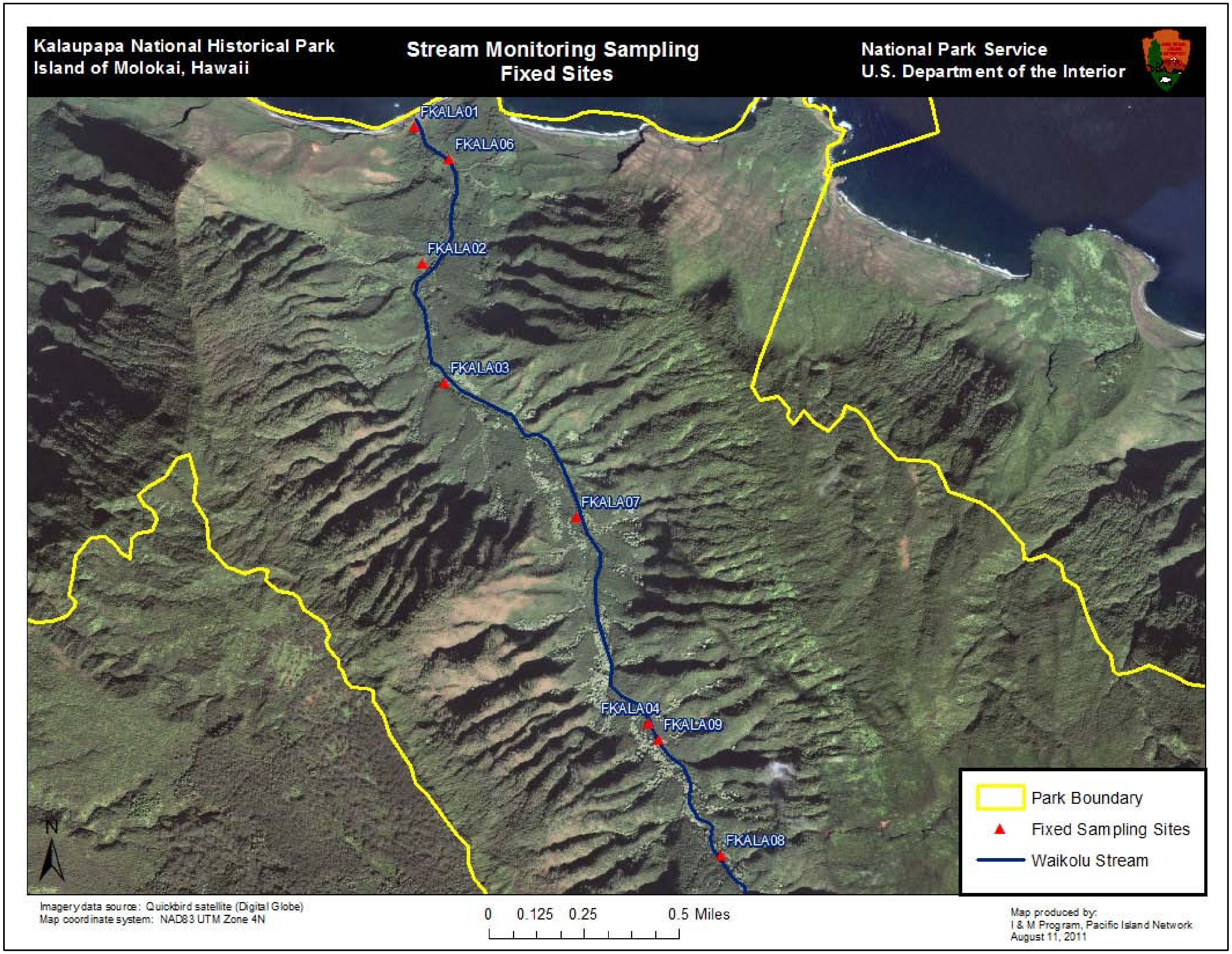


Figure A.7.6. Kalaupapa National Historical Park stream monitoring sampling fixed sites.

Table A.7.4. Stream monitoring sampling fixed sites for Kalaupapa National Historical Park.

Stream Name	Sampling Site	Easting	Northing	Datum
Waikolu	FKALA01	21.16919	-156.93028	WGS84
Waikolu	FKALA02	21.163983	-156.929987	WGS84
Waikolu	FKALA03	21.159446	-156.929134	WGS84
Waikolu	FKALA04	21.146504	-156.921382	WGS84
Waikolu	FKALA06	21.167935	-156.928961	WGS84
Waikolu	FKALA07	21.154313	-156.92413	WGS84
Waikolu	FKALA08	21.141463	-156.91863	WGS84
Waikolu	FKALA09	21.145874	-156.920992	WGS84

Appendix 8: Recommended field sampling schedule

Table A.8.1. Aquatic Sampling Schedule at each park for each protocol.

	Water Quality	Streams	Groundwater	Benthic Marine	Marine Fish	Anchialine Pools
January	KAHO, KALA, WAPA, AMME		AMME			
February	PUHO, PUHE, ALKA		KAHO			
March	HALE, NPSA		AMME	NPSA	NPSA	
April	KAHO, KALA, WAPA, AMME	WAPA	KAHO	WAPA	WAPA	
May	PUHO, PUHE, ALKA		AMME			PUHO, KAHO, ALKA, HAVO
June	HALE, NPSA	HALE	KAHO			
July	KAHO, KALA, WAPA, AMME	KALA	AMME	KALA	KALA	
August	PUHO, PUHE, ALKA		KAHO			
September	HALE, NPSA	NPSA	AMME			
October	KAHO, KALA, WAPA, AMME		KAHO	KAHO	KAHO	
November	PUHO, PUHE, ALKA		AMME			PUHO, KAHO, ALKA, HAVO
December	HALE, NPSA		KAHO			

Appendix 9: Data sheets: American Samoa

Data sheets for fish, shrimp, snails, and habitat characterization for streams in American Samoa are included in this appendix. Given that there is the potential for a lot of data to be collected at each quadrat and transect, it is recommended that adequate copies, including extra copies, of each datasheet be made prior to going to the field.

FISH DATASHEET SAMOA

Park Stream Reach Date

Quadrat (y, x) Route Observer

Record sizes in cm

Stiphodon	Sicyopterus	Kuhlia *rupestris* *salelea*	Total Tilapia: Total Poecilia:
Awaous	Eleotris	Anguilla *marmorata* *obscura*	V_x V_y
Microphis	Periophthalmus	Other	Tracker Depth (m)
Habitat Type:	Structure:	Depth (m):	

Habitat Type:
riffle (RF)
boulder riffle (BR)
run (RU)
cascade (CA)
falls (FA)
plunge-pool (PL)
pool (P)
eddy (ED)
backwater (BW)

Structure:
Algal Mat (AM)
Leaf Pack (LP)
Manmade Structure (MS)
Vegetation (VG)
Woody Debris (WD)
Root Wad (RT)
Rocks (cobble-to-boulder sized) (RK)
Bedrock (BR)
Filamentous Algae (FA)

Reach
Quadrat (y, x) Route Observer

Record sizes in cm

Stiphodon	Sicyopterus	Kuhlia *rupestris* *salelea*	Total Tilapia: Total Poecilia:
Awaous	Eleotris	Anguilla *marmorata* *obscura*	V_x V_y
Microphis	Periophthalmus	Other	Tracker Depth (m)
Habitat Type:	Structure:	Depth (m):	

Habitat Type:
riffle (RF)
boulder riffle (BR)
run (RU)
cascade (CA)
falls (FA)
plunge-pool (PL)
pool (P)
eddy (ED)
backwater (BW)

Structure:
Algal Mat (AM)
Leaf Pack (LP)
Manmade Structure (MS)
Vegetation (VG)
Woody Debris (WD)
Root Wad (RT)
Rocks (cobble-to-boulder sized) (RK)
Bedrock (BR)
Filamentous Algae (FA)

Page ___ of ___

Shrimp (ula vai)
Datasheet

Park:	**Stream:**	**Date:**
Reach:	**Method:**	**Observers:**

Species	**Length (mm)**	**Gravid (Y/N)**	**Segment**	**Species**	**Length (mm)**	**Gravid (Y/N)**	**Segment**

Snail (sisi vai)
Datasheet

Park:	**Stream:**	**Date:**
Reach:	**Observers:**	**Measure (name):**

Quadrat (y, x)	# eggs	# spat (<5mm)

Species	**Corrosion (check if present)**	**Length (mm)**	**Quadrat (y, x)**	**Species**	**Corrosion (check if present)**	**Length (mm)**	**Quadrat (y,x)**

Snail (sisi vai)
Datasheet

Species	Corrosion (check if present)	Length (mm)	Quadrat (y, x)	Species	Corrosion (check if present)	Length (mm)	Quadrat (y,x)

Habitat Assessment—American Samoa

Park: Stream: Reach: Date:
Flowtracker Operator: Observers :

Habitat Notes:					
Transect Location:		Wetted channel width (m):		Habitat Type (see codes below):	
Point	Tape Reading (m)	Depth (m)	Velocity (m/s)	Microhabitat Type (see codes below)	Structure
LEW					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
REW					
			Discharge (m^3/s)	**Error %**	

Habitat Type: riffle (RF) boulder riffle (BR) run (RU) cascade (CA) falls (FA) plunge-pool (PL) pool (P) eddy (ED) backwater (BW)

Structure: Algal Mat (AM) Leaf Pack (LP) Manmade Structure (MS) Vegetation (VG) Woody Debris (WD) Root Wad (RT) Rocks (cobble-to-boulder sized) (RK) Bedrock (BR)

Pebble Count

Reach: Date:

Transect Location: Wetted channel width (m): Observers:

Location	Size (cm)	Location	Size (cm)	Location	Size (cm)	Location	Size (cm)
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Riparian canopy closure (# intersections)
If stream is < 1m wide, only do center measurement.
Do measurements facing left and right banks if stream is > 1m wide.

Facing:	Left Bank	Center	Right Bank
# intersections:			

Transect Location: Wetted channel width (m): Observers:

Location	Size (cm)	Location	Size (cm)	Location	Size (cm)	Location	Size (cm)
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Riparian canopy closure (# intersections)
If stream is < 1m wide, only do center measurement.
Do measurements facing left and right banks if stream is > 1m wide.

Facing:	Left Bank	Center	Right Bank
# intersections:			

Transect Location: Wetted channel width (m): Observers:

Location	Size (cm)	Location	Size (cm)	Location	Size (cm)	Location	Size (cm)
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Riparian canopy closure (# intersections)
If stream is < 1m wide, only do center measurement.
Do measurements facing left and right banks if stream is > 1m wide.

Facing:	Left Bank	Center	Right Bank
# intersections:			

Note: 0=silt 999=bedrock

REACH CHARACTERIZATION DATASHEET

Park Name: ____

Stream Name: _______________________________ **Date:** _______-______-______

Reach: _______________________________

UTMs: ____

Observers:____

Description of reference location: ____

____

Distance to reference location: Upstream end: ___ feet meters **Downstream end:** ___ feet meters

Curvilinear reach length:_______ feet meters **Distance between transects:** _____ feet meters

Location of boundary markers: Upstream: left right both **Downstream:** left right both

Notes:____

____

Dominant Riparian Land Cover (circle one): Grassland Shrubs/Woodland Wetland Exposed Rock

Disturbed/Developed-Explain: ____

Geomorphic channel units; length measured in (circle one): meters feet **Beginning at:** US DS **end**

Riffle (RF), Boulder Riffle (BR), Run (RU), Glide (GL), Rapid (RD), Cascade (CA), Falls (FA), Chute (CH), Sheet (SH), Plunge-Pool (PL), Pool (P), Eddy (ED) , Backwater (BW) , Abandoned channel (AC).

	Type	Length (m)		Type	Length (m)		Type	Length (m)
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		

Appendix 10: Data sheets: Guam

Data sheets for fish, shrimp, snails, and habitat characterization for streams in Guam are included in this appendix. Given that there is the potential for a lot of data to be collected at each quadrat and transect, it is recommended that adequate copies, including extra copies, of each datasheet be made prior to going to the field.

FISH (ATOT) DATASHEET GUAM

Park Stream Reach Date

Quadrat (y, x) Route Observer

Record sizes in cm

Sicyopus	Stiphodon	Sicyopterus	V_x V_y Tracker Depth (m)
Kuhlia	**Eleotris**	**Awaous**	

Other:

Habitat Type:	Structure:	Depth (m):

Reach

Quadrat (y, x) Route Observer

Record sizes in cm

Sicyopus	Stiphodon	Sicyopterus	V_x V_y Tracker Depth (m)
Kuhlia	**Eleotris**	**Awaous**	

Other:

Habitat Type:	Structure:	Depth (m):

Habitat Type: riffle (RF) boulder riffle (BR) run (RU) cascade (CA) falls (FA) plunge-pool (PL) pool (P) eddy (ED) backwater (BW)

Structure: Algal Mat (AM) Leaf Pack (LP) Manmade Structure (MS) Vegetation (VG) Woody Debris (WD) Root Wad (RT) Rocks (cobble-to-boulder sized) (RK) Bedrock (BR) Filamentous Algae (FA)

Page ___ of ___

Shrimp (Uhang) Datasheet

Park:	**Stream:**	**Date:**
Reach:	**Method:**	**Observers:**

Species	Length (mm)	Gravid (Y/N)	Segment	Species	Length (mm)	Gravid (Y/N)	Segment

Snail (Akaleha')
Datasheet

Park:	Stream:	Date:
Reach:	Observers:	Measure (name):

Segment	# Eggs	# Spat
T1-T2		
T2-T3		
T3-T4		
T4-T5		
T5-T6		

Species	Corrosion (check if present)	Length (mm)	Segment	Species	Corrosion (check if present)	Length (mm)	Segment

Habitat Assessment--Guam

Park: Stream: Reach: Date:
Flowtracker Operator: Observers :

Habitat Notes:					
Transect Location:		Wetted channel width (m):		Habitat Type (see codes below):	
Point	Tape Reading (m)	Depth (m)	Velocity (m/s)	Microhabitat Type (see codes below)	Microhabitat Structure (see codes below)
LEW					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
REW					
			Discharge (m^3/s)	**Error %**	

Habitat Type: riffle (RF) boulder riffle (BR) run (RU) cascade (CA) falls (FA) plunge-pool (PL) pool (P) eddy (ED) backwater (BW)

Structure: Algal Mat (AM) Leaf Pack (LP) Manmade Structure (MS) Vegetation (VG) Woody Debris (WD) Root Wad (RT) Rocks (cobble-to-boulder sized) (RK) Bedrock (BR)

Pebble Count

Reach:

Date:

Transect Location: Wetted channel width (m): Observers:

Location	Size (cm)	Location	Size (cm)	Location	Size (cm)	Location	Size (cm)
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Riparian canopy closure (# intersections)
If stream is < 1m wide, only do center measurement.
Do measurements facing left and right banks if stream is > 1m wide.

Facing:	Left Bank	Center	Right Bank
# intersections:			

Transect Location: Wetted channel width (m): Observers:

Location	Size (cm)	Location	Size (cm)	Location	Size (cm)	Location	Size (cm)
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Riparian canopy closure (# intersections)
If stream is < 1m wide, only do center measurement.
Do measurements facing left and right banks if stream is > 1m wide.

Facing:	Left Bank	Center	Right Bank
# intersections:			

Transect Location: Wetted channel width (m): Observers:

Location	Size (cm)	Location	Size (cm)	Location	Size (cm)	Location	Size (cm)
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Riparian canopy closure (# intersections)
If stream is < 1m wide, only do center measurement.
Do measurements facing left and right banks if stream is > 1m wide.

Facing:	Left Bank	Center	Right Bank
# intersections:			

Note: 0=silt 999=bedrock

REACH CHARACTERIZATION DATASHEET

Park Name: ____

Stream Name: ______________________________ **Date:** _______-______-______

Reach: ______________________________

UTMs: ____

Observers:____

Description of reference location: ____

____

Distance to reference location: Upstream end: ___ feet meters **Downstream end:** ___ feet meters

Curvilinear reach length:_______ feet meters **Distance between transects:** _____ feet meters

Location of boundary markers: Upstream: left right both **Downstream:** left right both

Notes:____

____

Dominant Riparian Land Cover (circle one): Grassland Shrubs/Woodland Wetland Exposed Rock

Disturbed/Developed-Explain: ____

Geomorphic channel units; length measured in (circle one): meters feet **Beginning at:** US DS **end**

Riffle (RF), Boulder Riffle (BR), Run (RU), Glide (GL), Rapid (RD), Cascade (CA), Falls (FA), Chute (CH), Sheet (SH), Plunge-Pool (PL), Pool (P), Eddy (ED) , Backwater (BW) , Abandoned channel (AC).

	Type	Length (m)		Type	Length (m)		Type	Length (m)
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		

Appendix 11: Data sheets: Hawaii

Data sheets for fish, shrimp, snails, and habitat characterization for streams in Hawaii are included in this appendix. Given that there is the potential for a lot of data to be collected at each quadrat and transect, it is recommended that adequate copies, including extra copies, of each datasheet be made prior to going to the field.

FISH (OOPU) AND SHRIMP (OPAE) DATASHEET HAWAII

Park Stream Reach Date

Quadrat (y, x) Route Observer

Record sizes in cm

Lentipes concolor (alamoo)	*Sicyopterus stimpsoni* (nopili)	*Awaous guamensis* (nakea)	V_x V_y
Eleotris sandwicensis (akupa)	*Stenogobius hawaiiensis* (naniha)	*Macrobrachium lar*	Tracker Depth (m)

Total Hinana: ____________ Other fish_______________________ **Total Opae:** __________

Habitat Type:	Structure:	Depth (m):

Reach

Quadrat (y, x) Route Observer

Record sizes in cm

Lentipes concolor (alamoo)	*Sicyopterus stimpsoni* (nopili)	*Awaous guamensis* (nakea)	V_x V_y
Eleotris sandwicensis (akupa)	*Stenogobius hawaiiensis* (naniha)	*Macrobrachium lar*	Tracker Depth (m)

Total Hinana: ____________ Other fish_______________________ **Total Opae:** __________

Habitat Type:	Structure:	Depth (m):

Habitat Type: riffle (RF) boulder riffle (BR) run (RU) cascade (CA) falls (FA) plunge-pool (PL) pool (P) eddy (ED) backwater (BW)

Structure: Algal Mat (AM) Leaf Pack (LP) Manmade Structure (MS) Vegetation (VG) Woody Debris (WD) Root Wad (RT) Rocks (cobble-to-boulder sized) (RK) Bedrock (BR) Filamentous Algae (FA)

HAWAII SNAIL (HIHIWAI) DATASHEET

Park Stream Reach Date

Observers: Collect Measure

Quadrat (y,x) Route	spat < 5 mm	eggs

Quadrat (y,x) Route	spat < 5 mm	eggs

Quadrat (y,x) Route	spat < 5 mm	eggs

Quadrat (y,x) Route	spat < 5 mm	eggs

Quadrat (y,x) Route	spat < 5 mm	eggs

Habitat Assessment--Hawaii

Park: Stream: Reach: Date:
Flowtracker Operator: Observers :

Habitat Notes:

Transect Location: Wetted channel width (m): Habitat Type (see codes below):

Point	Tape Reading (m)	Depth (m)	Velocity (m/s)	Microhabitat Type (see codes below)	Microhabitat Structure (see codes below)
LEW					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
REW					
			Discharge (m^3/s)	**Error %**	

Habitat Type: riffle (RF) boulder riffle (BR) run (RU) cascade (CA) falls (FA) plunge-pool (PL) pool (P) eddy (ED) backwater (BW)

Structure: Algal Mat (AM) Leaf Pack (LP) Manmade Structure (MS) Vegetation (VG) Woody Debris (WD) Root Wad (RT) Rocks (cobble-to-boulder sized) (RK) Bedrock (BR)

Pebble Count

Reach: Date:

Transect Location: Wetted channel width (m): Observers:

Location	Size (cm)	Location	Size (cm)	Location	Size (cm)	Location	Size (cm)
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Riparian canopy closure (# intersections)
If stream is < 1m wide, only do center measurement.
Do measurements facing left and right banks if stream is > 1m wide.

Facing:	Left Bank	Center	Right Bank
# intersections:			

Transect Location: Wetted channel width (m): Observers:

Location	Size (cm)	Location	Size (cm)	Location	Size (cm)	Location	Size (cm)
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Riparian canopy closure (# intersections)
If stream is < 1m wide, only do center measurement.
Do measurements facing left and right banks if stream is > 1m wide.

Facing:	Left Bank	Center	Right Bank
# intersections:			

Transect Location: Wetted channel width (m): Observers:

Location	Size (cm)	Location	Size (cm)	Location	Size (cm)	Location	Size (cm)
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Riparian canopy closure (# intersections)
If stream is < 1m wide, only do center measurement.
Do measurements facing left and right banks if stream is > 1m wide.

Facing:	Left Bank	Center	Right Bank
# intersections:			

Note: 0=silt 999=bedrock

REACH CHARACTERIZATION DATASHEET

Park Name: ____

Stream Name: _______________________________ **Date:** _______-______-______

Reach: _______________________________

UTMs: ____

Observers:____

Description of reference location: ____

____

Distance to reference location: Upstream end: ___ feet meters **Downstream end:** ___ feet meters

Curvilinear reach length:_______ feet meters **Distance between transects:** _____ feet meters

Location of boundary markers: Upstream: left right both **Downstream:** left right both

Notes:____

____

Dominant Riparian Land Cover (circle one): Grassland Shrubs/Woodland Wetland Exposed Rock

Disturbed/Developed-Explain: ____

Geomorphic channel units; length measured in (circle one): meters feet **Beginning at:** US DS **end**

Riffle (RF), Boulder Riffle (BR), Run (RU), Glide (GL), Rapid (RD), Cascade (CA), Falls (FA), Chute (CH), Sheet (SH), Plunge-Pool (PL), Pool (P), Eddy (ED) , Backwater (BW) , Abandoned channel (AC).

	Type	Length (m)		Type	Length (m)		Type	Length (m)
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		

Appendix 12: Yearly Project Task List

Table A.12.1 Identification of each task by project stage, indicates who is responsible, and establishes the timing for each task. Note that the PACN Aquatic Ecologist will serve as the Project Lead, and the Aquatic Biological Technician will serve as the Field Lead. Protocol sections and SOPs are referred to as appropriate.

Project Stage	Task Description	Responsibility	Timing
Preparation	Initiate announcements for seasonal technician positions, begin hiring	Project lead (PACN aquatic ecologist)	
	Notify data manager and GIS specialist of needs for the coming season (field maps, GPS support, training)	Project lead	
	Meet (or conference call) to recap past field season, discuss the upcoming field season, and document any needed changes to field sampling protocols or the working database	Project lead, aquatic biotech (field lead), park staff, data manager, GIS specialist	
	Ensure all project compliance needs and permitting are completed for the coming season	Aquatic biotech, project lead, park staff	
	Provide names of field crew to park staff	Project lead	
	Plan schedule and logistics, including ordering any needed equipment and supplies (SOP #2)	Aquatic biotech, assisted by project lead	
	Inform GIS specialist and data manager of specific needs for upcoming field season	Project lead, assisted by aquatic biotech	
	Generate field navigation reports, roster of sample points and coordinates from the database (SOP #5)	Aquatic biotech, assisted by GIS specialist	
	Prepare and print field maps (SOP #3)	Aquatic biotech	
	Update and load data dictionary, background maps, and target coordinates into GPS units (SOP #5)	GIS specialist	
	Ensure that project workspace is ready for use and GPS download software is loaded at each park (SOP #25)	Project lead, data manager, GIS specialist	
	Implement working database copy	Data manager	
	Initiate computer access and key requests (may need park-specific dates)	Aquatic biotech	
	Provide field crew email addresses and user logins to data manager	Aquatic biotech	
	Provide database/GPS training as needed	Data manager and GIS specialist	
	Train field crew in species identification, habitat characterization, and safety (SOP #7)	Aquatic biotech	
	Examination and certification of field observer qualifications, enter training results into database (SOP #7)	Aquatic biotech	
Data Acquisition	Notify park staff and project lead of tour itinerary	Aquatic biotech	
	Collect field observations and position data during field trips	Aquatic biotech	
	Review data forms after each day	Aquatic biotech	
	Check in with park staff	Aquatic biotech	
	Debrief crew on operations, field methods, gear needs	Aquatic biotech	
Data Entry & Processing	Download GPS data and email files to GIS specialist for correction (SOP #5)	Aquatic biotech	

Project Stage	Task Description	Responsibility	Timing
	Download and process digital images (SOP #29)	Aquatic biotech	
	Enter data into working copy of the database (SOP #26)	Aquatic biotech	
	Verification of accurate transcription as data are entered	Aquatic biotech	
	Correct GPS data and send screen capture to field lead and project lead for review	GIS specialist	
	Periodic review of GPS location data and database entries for completeness and accuracy	Aquatic biotech	
	Merge, correct, and export GPS data. Upload processed and verified coordinates to database	GIS specialist	
Product Development	Complete field season report (SOP #32)	Aquatic biotech assisted by project lead	
Product Delivery	Send field season report to NPS lead, park biologists, data manager, and GIS specialist (SOP #30)	Project lead	
Quality Review	Quality review and data validation using database tools (SOP #27)	Project lead	
	Prepare coordinate summaries and/or GIS layers and data sets as needed for spatial data review	GIS specialist	
	Joint quality review of GIS data, determine best coordinates for subsequent mapping and fieldwork	Project lead and GIS specialist	
Metadata	Identify any sensitive information contained in the data set (SOP #33)	Project lead and park staff	
	Update project metadata records (SOP #31)	Project lead and park staff	
Data Certification & Delivery	Certify the season's data and complete the certification report (SOP #27)	Project lead	
	Deliver certification report, certified data, digital photographs, and updated metadata to Data Manager (SOP #30)	Project lead	
	Upload certified data into master project database, store data files in PACN Digital Library [1] (SOP #34)	Data manager	
	Notify Project Lead of uploaded data ready for analysis and reporting	Data manager	
	Update project GIS data sets, layers and associated metadata records	GIS specialist	
	Finalize and parse metadata records, store in PACN Digital Library [1] (SOP #31)	Data manager and GIS specialist	
Data Analysis	Check station and stream level data for normality (see SOP #32).	Project lead assisted by aquatic biotech	
	Create bar graphs of data (see SOP #32).	Project lead assisted by aquatic biotech	
	Analyze data for trends over time using yet to be determined statistical methods (see SOP #32).	Project lead assisted by aquatic biotech	
	Integrate biotic data with habitat data using a multivariate approach (see SOP #32).	Project lead assisted by aquatic biotech	
Reporting & Product Development	Export automated summary queries and reports from database	Data analyst	
	Produce park-wide and transect-specific map output for archives	GIS specialist	

Project Stage	Task Description	Responsibility	Timing
	Generate report-quality map output for reports	GIS specialist	
	Acquire the proper report template from the NPS website, create annual report	Data analyst and project lead	
	Screen all reports and data products for sensitive information (SOP #33)	Project lead	
	Prepare draft report and distribute to park biologists for preliminary review	Project lead assisted by aquatic biotech	
Product Delivery	Submit draft I&M report to program manager for review	Project lead	
	Review report for formatting and completeness, notify project lead of approval or need for changes	Program manager	
	Upload completed report to PACN Digital Library [1] submissions folder, notify data manager (SOP #30)	Project lead	
	Deliver other products according to the delivery schedule and instructions (SOP #30)	Project lead	
	Product check-in	Data manager	
Posting & Distribution	Submit metadata to IRMA Portal [2]	Data manager	
	Create IRMA Portal [2] record, post reports to the IRMA Portal [2]	Data manager	
	Update IRMA Portal [2] records according to data observations	Data manager	
	Submit certified data and GIS data sets to IRMA Portal [2]	Data manager	
Archival & Records Management	Store finished products in PACN Digital Library [1]	Data manager	
	Review, clean up and store and/or dispose of project files according to NPS Director's Order #19 [3]	Data manager assisted by aquatic biotech	
Season Close-out	Inventory equipment and supplies	Aquatic biotech	
	Conference call to discuss recent field season (close out); discuss who needs to do what to get data ready for analysis	Project lead, aquatic biotech (field lead), park staff, data manager and GIS specialist	
	Discuss and document needed changes to analysis and reporting procedures	Project lead, assisted by aquatic biotech, park staff, and data manager	

[1] The PACN Digital Library is a hierarchical digital filing system stored on the PACN file server. Network users have read-only access to these files, except where information sensitivity may preclude general access.
[2] The IRMA Portal is a clearinghouse for natural resource data, metadata, bibliographic records, and park species information (http://irma.nps.gov/App/Portal/Home). Only non-sensitive information is posted to the IRMA Portal. Refer to the protocol section on sensitive information for details.
[3] NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: http://data2.itc.nps.gov/npspolicy/DOrders.cfm

Appendix 13: Database Documentation

The database for this project consists of four types of tables: core tables describing the “who, where, and when” of data collection, project-specific tables, lookup tables that contain domain constraints for other tables, and cross reference tables that link lookup tables with data tables. Although core tables are based on PACN standards, they may contain fields, domains or descriptions that have been added or altered to meet project objectives.

The database includes the following standard tables:

tbl_Parks	Sample sites – individual parks
tbl_Locations	Sample locations – streams where sampling is being conducted
tbl_Sites	Sampling unit locations along the stream
tbl_Events	Data collection event for a given location
tbl_Images	Images associated with sample locations
tbl_Db_Meta	Database description and links to I&M metadata tools
tbl_Db_Revisions	Database revision history data
tbl_QA_Results	Data validation results from using the quality review tool

The following are project-specific data tables:

tbl_Fish_Shrimp	Hawaiian fish and crustacean sampling information
tbl_Snails	Mollusc sampling information
tbl_Shrimp	Crustacean sampling information (NPSA)
tbl_Transects	Transect characterization for each stream site
tbl_Site_Geo_Unit	Geomorphic channel unit measurements
tbl_Pebbles	Pebble count for transects
tbl_Points	Transect point measurements
tbl_Canopy	Riparian canopy closure measurements

The following are a few of the more prominent, standard lookup tables:

tlu_Contacts	Contact data for project-related personnel
tlu_Taxa	Taxon table for sampling events
tlu_Enumerations	Enumerated lookup table

The following are a few of the more prominent, standard cross-reference tables:

xref_Event_Contacts	Cross-reference table for event contacts
xref_Site_Cover	Cross-reference table for dominant riparian land cover
xref_Site_Geo_Unit	Cross-reference table for geomorphic channel units
xref_Shrimp_Taxa	Cross-reference table for crustacean taxa
xref_Shrimp_Structures	Cross-reference table for crustacean structures
xref_Fish_Shrimp_Taxa	Cross-reference table for Hawaiian fish and crustacean taxa
xref_Fish_Shrimp_Structures	Cross-reference table for Hawaiian fish and crustacean structures
xref_Snails_Taxa	Cross-reference table for mollusc taxa
xref_Snails_Structures	Cross-reference table for mollusc structures
xref_Point_Structures	Cross-reference table for point structures

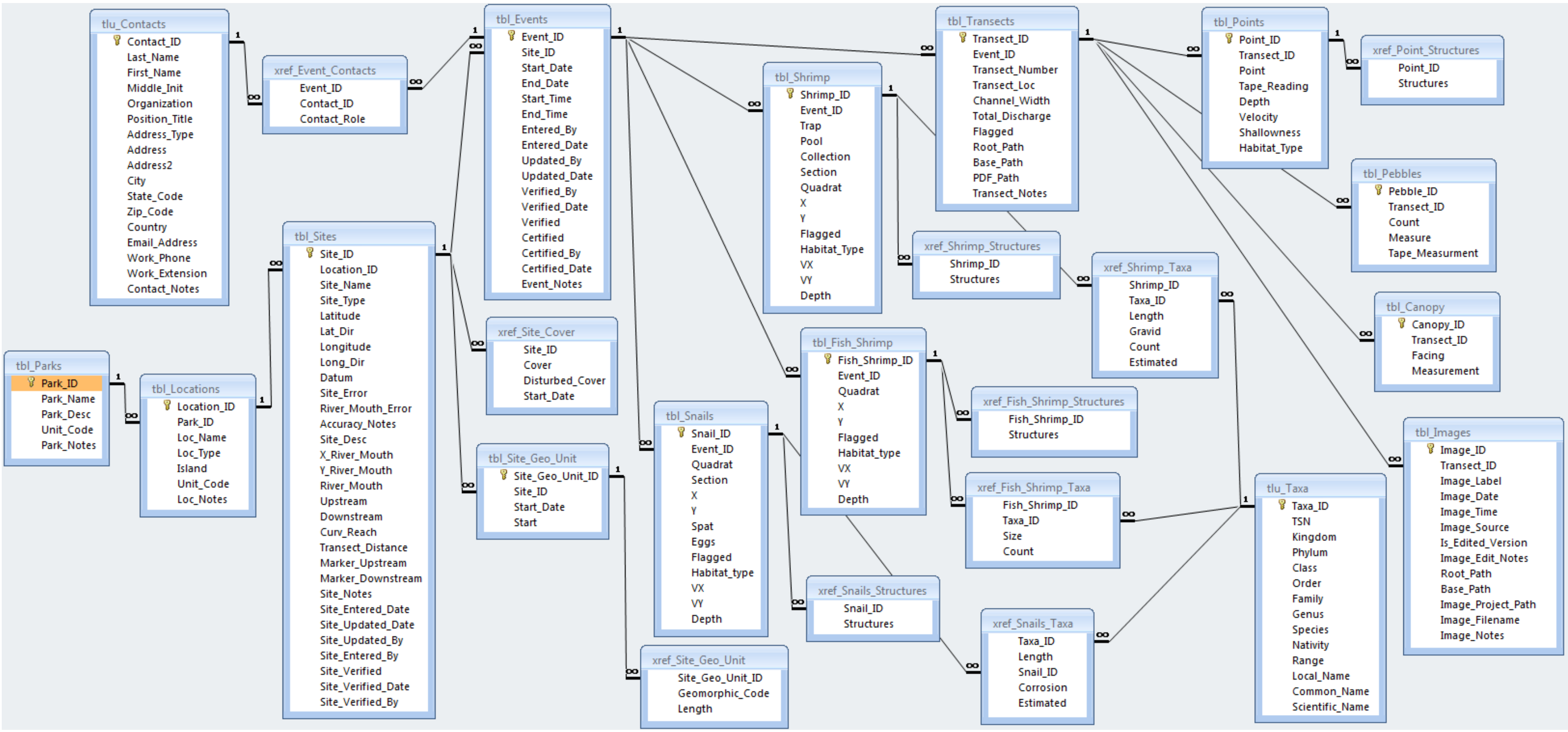


Figure A.13.1. Data model for the PACN Stream Monitoring database.

Database Tables

tbl_ Parks: Sample sites – individual parks

Field	Primary?	Data Type	Size	Description
Park_ID	Yes	Text	50	Unique identifier for park records
Park_Name	No	Text	100	Unique name or code for a site
Park_Desc	No	Text	255	Park description
Unit_Code	No	Text	4	Four letter Park, Monument or Network code
Park_Notes	No	Memo	-	General notes on the park

tbl_ Locations: Sample locations – streams where sampling is being conducted

Field	Primary?	Data Type	Size	Description
Location_ID	Yes	Text	50	Unique identifier for location records
Park_ID	No	Text	50	Link to tbl_Parks
Loc_Name	No	Text	50	Name of the location (stream name)
Loc_Type	No	Text	10	Location type category (annual or perennial)
Island	No	Text	25	The island on which the stream is located
Unit_Code	No	Text	4	Four letter Park, Monument or Network code
Loc_Notes	No	Memo	-	General notes on the location

tbl_ Sites: Sampling unit locations along the stream

Field	Primary?	Data Type	Size	Description
Site_ID	Yes	Text	50	Unique identifier for site records
Location_ID	No	Text	50	Link to tbl_Locations
Site_Name	No	Text	50	Name of the site (station)
Site_Type	No	Text	25	Site type category
Latitude	No	Number	Double	Decimal degrees latitude
Lat_Dir	No	Text	25	Latitude direction (north or south)
Longitude	No	Number	Double	Decimal degrees longitude
Long_Dir	No	Text	25	Longitude direction (east or west)
Datum	No	Text	5	Datum of mapping ellipsoid
Site_Error	No	Number	Double	Estimated GPS error of site coordinates
River_Mouth_Error	No	Number	Double	Estmated GPS error of river mouth coordinates
Accuracy_Notes	No	Text	255	Positional accuracy notes

Site_Desc	No	Memo	-	General description of the site
X_River_Mouth	No	Number	Double	X coordinate of river mouth
Y_River_Mouth	No	Number	Double	Y coordinate of river mouth
River_Mouth	No	Number	Double	Distance to river mouth
Upstream	No	Number	Double	Distance to the reference location from the upstream end in meters
Downstream	No	Number	Double	Distance to the reference location from the downstream end in meters
Curv_Reach	No	Number	Double	The curvilinear reach length in meters of the site
Transect_Distance	No	Number	Double	The distance between transect in meters
Marker_Upstream	No	Text	5	Location of the upstream boundary marker; left, right, both
Marker_Downstream	No	Text	5	Location of the downstream boundary marker; left, right, both
Site_Notes	No	Memo	-	General notes on the site
Site_Entered_Date	No	Date/Time	-	Date on which data entry occurred for this record
Site_Entered_By	No	Text	50	Person who entered the data for this record
Site_Updated_Date	No	Date/Time	-	Date of the most recent edits to this record
Site_Updated_By	No	Text	50	Person who made the most recent updates to this record
Site_Verified	No	Boolean	-	Has the record been verified
Site_Verified_Date	No	Date/Time	-	Date that the record was verified
Site_Verified_By	No	Text	50	Person who verified the record

tbl_ Events: Data collection event for a given location

Field	***Primary?***	***Data Type***	***Size***	***Description***
Event_ID	Yes	Text	50	Unique identifier for event records
Site_ID	No	Text	50	Link to tbl_Sites
Start_Date	No	Date/Time	-	Starting date for the event
End_Date	No	Date/Time	-	Ending date for the event
Start_Time	No	Date/Time	-	Starting time for the event
End_Time	No	Date/Time	-	Ending time for the event
Entered_By	No	Text	50	Person who entered the data for this event
Entered_Date	No	Date/Time	-	Date on which data entry occurred
Updated_By	No	Text	50	Person who made the most recent updates
Updated_Date	No	Date/Time	-	Date of the most recent edits
Verified_By	No	Text	50	Person who verified accurate data transcription

Verified_Date	No	Date/Time	-	Date on which data was verified
Verified	No	Boolean	-	Has the data been verified
Certified	No	Boolean	-	Has the data been certified
Certified_By	No	Text	50	Person who certified data for accuracy and completeness
Certified_Date	No	Date/Time	-	Date on which data were certified
Event_Notes	No	Memo	-	General notes on the event

tbl_ Images: Images associated with sample locations

Field	***Primary?***	***Data Type***	***Size***	***Description***
Image_ID	Yes	Text	50	Unique identifier for image records
Image_Date	No	Date/Time	-	Date on which the image was created, if different from the sampling event date
Image_Edit_Notes	No	Memo	-	Comments about the editing or processing performed on the image
Image_Filename	No	Text	100	Name of the image including extension (.jpg) but without the image path
Image_Label	No	Text	100	Image caption or label
Image_Notes	No	Memo	-	Notes or comments about the image
Image_Project_Path	No	Text	100	Location of the image from the main project folder or image library
Image_Source	No	Text	50	Name of the person or organization that created the image
Image_Time	No	Date/Time	-	Time image was taken.
Is_Edited_Version	No	Boolean	-	Indicates whether this version of the image is the edited (originals = False)
Transect_ID	No	Text	50	Link to tbl_Transects
Root_Path	No	Text	255	The root path for the linked image file. This will change upon re-linking of database
Base_Path	No	Text	255	The base file path for the linked image file. This will stay the same no matter where the root folder is

tbl_ Site_Geo_Unit: Geomorphic channel unit measurements

Field	***Primary?***	***Data Type***	***Size***	***Description***
Site_Geo_Unit_ID	Yes	Text	50	Unique identifier for geomorphic channel unit records
Site_ID	No	Text	50	Link to tbl_Sites
Start_Date	No	Date/Time	-	Date of data record
Start	No	Text	10	Beginning at upstream or downstream

tbl_Transects: Transect characterization for each stream site

Field	*Primary?*	*Data Type*	*Size*	*Description*
Transect_ID	Yes	Text	50	Unique identifier for transect records
Event_ID	No	Text	50	Link to tbl_Events
Transect_Number	No	Text	50	Transect number
Transect_Loc	No	Number	Double	Transect location in relation to the reference location; meters upstream from reference location
Channel_Width	No	Number	Double	Wetted channel width in meters
Total_Discharge	No	Text	25	Total discharge for transect point measurements
Flagged	No	Boolean	-	Indicates that the record needs to be reviewed for accuracy
Root_Path	No	Text	255	The root path for the linked PDF file. This will change upon re-linking of the database
Base_Path	No	Text	255	The base file path for the linked PDF file. This will stay the same no matter where the root folder is
PDF_Path	No	Text	255	File location of the PDF
Transect_Notes	No	Memo	-	Transect notes

tbl_Pebbles: Pebble count for transects

Field	*Primary?*	*Data Type*	*Size*	*Description*
Pebble_ID	Yes	Text	50	Unique identifier for pebble records
Transect_ID	No	Text	50	Link to tbl_Transects
Count	No	Number	Lng Int	Pebble count number
Measure	No	Number	Double	B-axis diameter of pebble (cm)
Tape_Measurement	No	Number	Double	Tape measurement (m)

tbl_ Points: Transect point measurements

Field	*Primary?*	*Data Type*	*Size*	*Description*
Point_ID	Yes	Text	50	Unique identifier for point records
Transect_ID	No	Text	50	Link to tbl_Transects
Point	No	Text	25	Point name
Tape_Reading	No	Number	Double	Measuring tape reading across the transect for the point, in meters
Depth	No	Text	25	Depth in meters at the point
Velocity	No	Text	5	Velocity
Shallowness	No	Boolean	-	Is it too shallow for velocity measurement?
Habitat_Type	No	Text	2	Habitat type

tbl_ Canopy: Riparian canopy closure measurements

Field	Primary?	Data Type	Size	Description
Canopy_ID	Yes	Text	50	Unique identifier for canopy records
Transect_ID	No	Text	50	Link to tbl_Transects
Facing	No	Text	25	Direction of measurement
Measurement	No	Text	25	Riparian canopy closure measurement

tbl_ Fish_Shrimp: Hawaiian fish and crustacean sampling information

Field	Primary?	Data Type	Size	Description
Fish_Shrimp_ID	Yes	Text	50	Unique identifier for fish and crustacean records
Event_ID	No	Text	50	Link to tbl_Events
Quadrat	No	Text	50	Quadrat for sampling
X	No	Text	50	X section of route taken for the sampling
Y	No	Text	50	Y section of route taken for the sampling
Habitat_Type	No	Text	5	Habitat type
Flagged	No	Boolean	-	Indicates that the record needs to be reviewed for accuracy.
VX	No	Number	Double	Velocity X of quadrat
VY	No	Number	Double	Velocity Y of quadrat
Depth	No	Number	Double	Depth of quadrat (m)

tbl_ Snails: Mollusc sampling information

Field	Primary?	Data Type	Size	Description
Snail_ID	Yes	Text	50	Unique identifier for mollusc records
Event_ID	No	Text	50	Link to tbl_Events
Quadrat	No	Text	50	Quadrat for sampling
Section	No	Text	25	Section number
X	No	Text	50	X section of route taken for the sampling
Y	No	Text	50	Y section of route taken for the sampling
Spat	No	Number	Double	Number of spat counted
Eggs	No	Number	Double	Number of eggs counted
Habitat_Type	No	Text	5	Habitat type
Flagged	No	Boolean	-	Indicates that the record needs to be reviewed for accuracy.
VX	No	Number	Double	Velocity X of section

VY	No	Number	Double	Velocity Y of section
Depth	No	Number	Double	Depth of section (m)

tbl_ Shrimp: Crustacean sampling information (NPSA)

Field	*Primary?*	*Data Type*	*Size*	*Description*
Shrimp_ID	Yes	Text	50	Unique identifier for crustacean records
Event_ID	No	Text	50	Link to tbl_Events
Trap	No	Text	100	Trap number or name
Pool	No	Text	50	The pool number the shrimp were sampled in
Collection	No	Text	50	Collection method (net, trap, electrofishing, or visual)
Section	No	Text	25	Section number
Quadrat	No	Text	50	Quadrat for sampling
X	No	Text	50	X section of route taken for the sampling
Y	No	Text	50	Y section of route taken for the sampling
Habitat_Type	No	Text	5	Habitat type
Flagged	No	Boolean	-	Indicates that the record needs to be reviewed for accuracy.
VX	No	Number	Double	Velocity X of quadrat
VY	No	Number	Double	Velocity Y of quadrat
Depth	No	Number	Double	Depth of quadrat (m)

tbl_ Db_Meta: Database description and links to I&M metadata tools

Field	*Primary?*	*Data Type*	*Size*	*Description*
Db_Meta_ID	Yes	Text	50	Unique Local primary key
Db_Desc	No	Memo	-	Description of the database purpose
DSC_GUID	No	Text	50	Link to I&M Dataset Catalog desktop metadata tool
Meta_File_Name	No	Text	50	Name of the metadata file that describes this NRDT data file (must be in the same directory as this data file)
Meta_MID	No	Text	255	Link to NPS Data Store

tbl_ Db_Revisions: Database revision history data

Field	*Primary?*	*Data Type*	*Size*	*Description*
Revision_ID	Yes	Text	50	Unique Database revision (version) number or code
Db_Meta_ID	No	Text	50	Link to tbl_DB_Meta
Revision_Contact_ID	No	Text	50	Link to tlu_Contacts

Revision_Date	No	Date/Time	-	Database revision date
Revision_Desc	No	Memo	-	Revision description
Revision_Reason	No	Memo	-	Reason for the database revision

tbl_ QA_Results: Data validation results from using the quality review tool

Field	***Primary?***	***Data Type***	***Size***	***Description***
Query_Name	No	Text	100	Name of query
Data_Scope	No	Byte	-	Scope of data
Time_Frame	No	Text	30	Time frame of data records
Query_Type	No	Text	20	Type of query
Query_Result	No	Text	50	The number of records returned by the query
Query_Run_Time	No	Date/Time	-	Most recent run time of the query
Query_Description	No	Memo	-	Query description
Query_Expression	No	Memo	-	Expression used to run query
Remedy_Desc	No	Memo	-	Action taken to fix the error
Remedy_Date	No	Date/Time	-	Remedy date
QA_User	No	Text	50	Remedy by
Is_Done	No	Boolean	-	Was the query checked

xref_Site_Cover: Cross-reference table for dominant riparian land cover

Field	***Primary?***	***Data Type***	***Size***	***Description***
Site_ID	No	Text	50	Link to tbl_Sites
Cover	No	Text	50	Dominant riparian land cover; grassland, shrubs/ woodland, wetland, exposed rock, wet forest, disturbed/ developed
Disturbed_Cover	No	Memo	-	If the dominant riparian land cover is disturbed/ developed, the description of the land cover
Start_Date	No	Date/Time	-	Date of data record

xref_Site_Geo_Unit: Cross-reference table for geomorphic channel units

Field	***Primary?***	***Data Type***	***Size***	***Description***
Site_Geo_Unit_ID	No	Text	50	Link to tbl_Site_Geo_Unit
Geomorphic_Code	No	Text	2	Two letter abbreviation for the geomorphic channel unit from tlu_Enumerations
Length	No	Number	Double	Length in meters of the geomorphic channel units

xref_Fish_Shrimp_Structures: Cross-reference table for Hawaiian fish and crustacean structures

Field	*Primary?*	*Data Type*	*Size*	*Description*
Fish_Shrimp_ID	No	Text	50	Link to tbl_Fish_Shrimp
Structures	No	Text	25	Structures present

xref_Fish_Shrimp_Taxa: Cross-reference table for Hawaiian fish and crustacean taxa

Field	*Primary?*	*Data Type*	*Size*	*Description*
Fish_Shrimp_ID	No	Text	50	Link to tbl_Fish_Shrimp
Taxa_ID	No	Text	50	Link to tlu_Taxa
Size	No	Text	50	Size in centimeters
Count	No	Number	Lng Int	Total number of fish or shrimp species counted for the

xref_Snails_Structures: Cross-reference table for mollusc structures

Field	*Primary?*	*Data Type*	*Size*	*Description*
Snail_ID	No	Text	50	Link to tbl_Snails
Structures	No	Text	25	Structures present size class

xref_Snails_Taxa: Cross-reference table for mollusc taxa

Field	*Primary?*	*Data Type*	*Size*	*Description*
Snail_ID	No	Text	50	Link to tbl_Snails
Taxa_ID	No	Text	50	Link to tlu_Taxa
Length	No	Number	Double	Length of species in mm
Corrosion	No	Boolean	-	Corrosion presence/absence
Estimated	No	Boolean	-	Was the species length estimated?

xref_Shrimp_Structures: Cross-reference table for crustacean structures

Field	*Primary?*	*Data Type*	*Size*	*Description*
Shrimp_ID	No	Text	50	Link to tbl_Shrimp
Structures	No	Text	25	Structures present

xref_Shrimp_Taxa: Cross-reference table for crustacean taxa

Field	*Primary?*	*Data Type*	*Size*	*Description*
Shrimp_ID	No	Text	50	Link to tbl_Shrimp

Taxa_ID	No	Text	50	Link to tlu_Taxa
Length	No	Number	Double	Length of species
Gravid	No	Text	20	Gravid?
Count	No	Number	Lng Int	Total number of shrimp species counted
Estimated	No	Boolean	-	Was the species length estimated?

xref_Point_Structures: Cross-reference table for point structures

Field	***Primary?***	***Data Type***	***Size***	***Description***
Point_ID	No	Text	50	Link to tbl_Points
Structures	No	Text	50	Structure present

xref_Event_Contacts: Cross-reference table for event contacts

Field	***Primary?***	***Data Type***	***Size***	***Description***
Contact_ID	No	Text	50	Link to tlu_Contacts
Contact_Role	No	Text	50	The contact's role in the protocol
Event_ID	No	Text	50	Link to tbl_Events

tlu_Contacts: Contact data for project-related personnel

Field	***Primary?***	***Data Type***	***Size***	***Description***
Contact_ID	Yes	Text	50	Unique identifier for contact records
Address	No	Text	50	Street address
Address_Type	No	Text	50	Address (mailing, physical, both) type
Address2	No	Text	50	Address line 2, suite, apartment number
City	No	Text	50	City or town
Contact_Notes	No	Memo	-	Contact notes
Country	No	Text	50	Country
Email_Address	No	Text	50	E-mail address
First_Name	No	Text	50	First name
Last_Name	No	Text	50	Last name
Middle_Init	No	Text	4	Middle initial
Organization	No	Text	50	Organization or employer
Position_Title	No	Text	50	Title or position description
State_Code	No	Text	8	State or province
Work_Extension	No	Text	50	Phone extension

Work_Phone	No	Text	50	Phone number
Zip_Code	No	Text	50	Zip code

tlu_Enumerations: Enumerated lookup table

Field	***Primary?***	***Data Type***	***Size***	***Description***
Enum_Group	Yes	Text	50	Category for lookup value
Enum_Code	No	Text	50	Code for lookup values
Enum_Description	No	Memo	-	Lookup value description
Sort_Order	No	Number	Integer	Order in which to sort lookup values

tlu_Taxa: Taxon table for sampling events

Field	***Primary?***	***Data Type***	***Size***	***Description***
Taxa_ID	Yes	Text	50	Unique identifier for species records
Common_Name	No	Text	50	Common name of species
Family	No	Text	50	Taxonomic family
Genus	No	Text	50	Taxonomic genus
Nativity	No	Text	50	Status; native, non-native
Scientific_Name	No	Text	100	Scientific name of species
Species	No	Text	50	Taxonomic species
Kingdom	No	Text	50	Taxonomic kingdom
Phylum	No	Text	50	Taxonomic phylum
TSN	No	Number	4	Taxonomic serial number from ITIS
Class	No	Text	50	Taxonomic class
Order	No	Text	50	Taxonomic order
Hawaiian_Name	No	Text	50	Hawaiian name of species
Range	No	Text	50	Range of nativity

Appendix 14: Analysis Log File Checklist

Stream:		
Vital Sign	Analysis	Date Completed
Fish, Shrimp, & Snails	<u>Station</u>	
	For each species at each station, check for normality of the distribution for size and abundance.	
	For each species at each station, generate a table of mean and standard deviation of size and abundance (add to table that contains data from previous years). Each table will represent a single station.	
	For each species at each station, plot mean and standard deviation of size and abundance (add to plot that contains data from previous years). Each plot will represent at single station.	
	<u>Stream</u>	
	For each species at all stations in the stream, generate a table of mean and standard deviation of size and abundance over a longitudinal gradient (add to table that contains data from previous years). Each table will represent all stations in a stream.	
	For each species at all stations in the stream, generate a plot of mean and standard deviation of size and abundance over a longitudinal gradient (stack with plots that contains data from previous years). Each plot will represent all stations in a stream.	
	<u>Trend</u>	
	To be determined	
Habitat Characteristics	<u>Station</u>	
	For each habitat characteristic at each station, check for normality of the distribution of the habitat characteristic.	
	For each habitat characteristic at each station, generate a table of mean and standard deviation of the habitat characteristic (add to table that contains data from previous years). Each table will represent a single station.	
Stream:		
Vital Sign	Analysis	Date Completed
	For each habitat characteristic at each station, plot mean and standard deviation of the habitat characteristic (add to plot that contains data from previous years). Each plot will represent at single station.	
	<u>Stream</u>	
	For each habitat characteristic at all stations in the stream, generate a table of mean and standard deviation of the habitat characteristic over a longitudinal gradient (add to table that contains data from previous years). Each table will represent all stations in a stream.	
	For each habitat characteristic at all stations in the stream, generate a plot of mean and standard deviation of the habitat characteristic over a longitudinal gradient (stack with plots that contains data from previous years). Each plot will represent all stations in a stream.	
	<u>Trend</u>	
	To be determined	

Appendix 15: Pacific Islands Stream Monitoring Report: Example Summary of Vital Signs Data

Here we present example results of annual monitoring of abundance data for three fish taxa in Unknown stream collected in 2007. The data presented here is used for example purposes only and should not be used as part of actual data analysis activities. The 2007 data is plotted with data from previous years to demonstrate trends in abundance over time and space. Trends observed in the plots are discussed in the corresponding figure legends. This data is a subset of a larger data set that includes annual information on the size and abundance of fish, shrimp, and snails, as well as habitat characteristics, at multiple sites within each stream being monitored. Detailed methods and results for all data can be found in the Vital Signs Monitoring Protocol Annual Report. (Note: Abundance data is presented here for a subset of fish taxa in Unknown Stream as an example. However, data included in future reports may include size and/or habitat data for other taxa in other streams, depending on which data is expected to be of interest to park managers.)

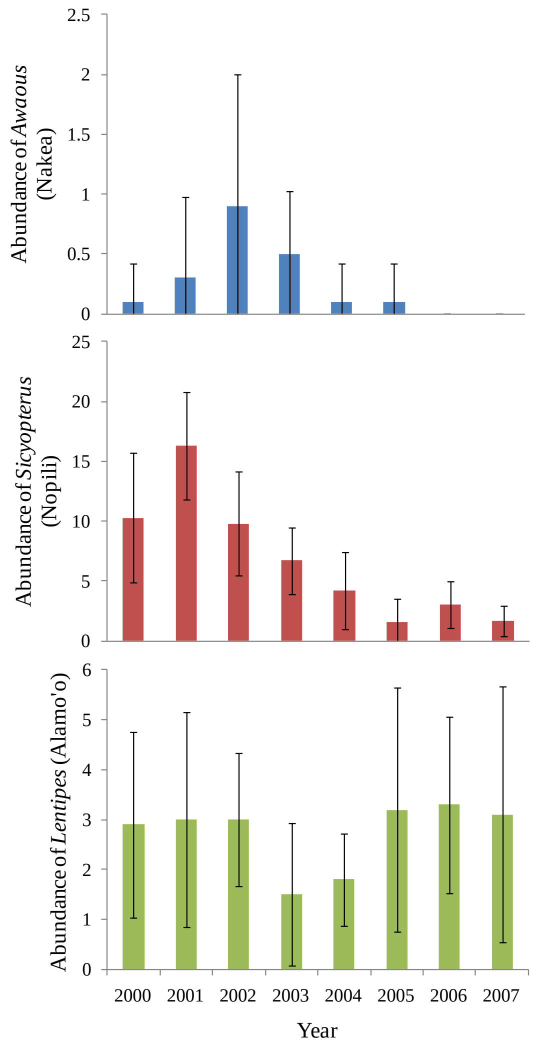


Figure A.15.1. Average abundance of Nakea, Nopili, and Alamo'o in Unknown Stream at Station D (160 meters from the mouth) from 2000-2007. Error bars equal one standard deviation. Note the difference in scale on the y-axes. Nakea has consistently been the least abundant of the three taxa over the sampling period with average station abundances less than 1 fish. Given the low abundances of Nakea it is difficult to extract any meaningful temporal trend information from this plot. Nopili was the most abundant taxa with station averages ranging from 1.6-16.3 fish. Nopili has decreased in abundance from 2001-2005 and abundances have remained low since 2005. Alamo'o displayed intermediate abundances with station averages decrease in abundance of Alamo'o during 2003 and 2004. However, since 2004, abundances have increased to values similar to those measured earlier in the decade.

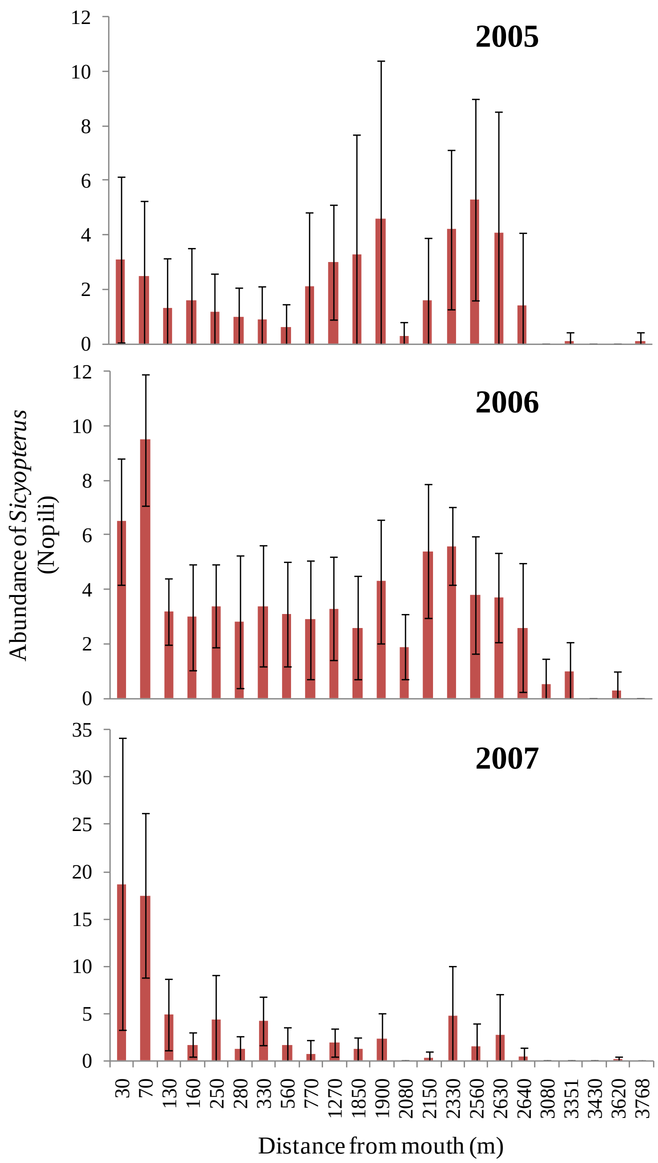


Figure A.15.2. Average abundance of Nopili in Unknown Stream at stations along a longitudinal gradient from the mouth to the headwaters in 2005, 2006, and 2007. Error bars equal one standard deviation. Note the difference in scale on the y-axes. In general, there were more Nopili within 100 m of the mouth as compared to stations further upstream in all three years. The average abundance of Nopili near the mouth increased from 2005 (~3 fish) to 2006 (~8 fish) and 2007 (~20 fish). In addition to the peak in abundances near the mouth, there was also a peak in abundance of Nopili between 2000 and 3000 meters upstream of the mouth in 2005 and 2006. This trend was less pronounced in 2007. Fewer than 1 Nopili per station on average were observed at distances greater than 3000 m upstream from the mouth in all three years. Summary Highlights

1) 160 m upstream from the mouth of Unknown Stream, Nopili has been the most abundant of the fish species analyzed over the previous 7 years followed by Alamo'o and Nakea.

2) Nopili has decreased in average abundance from 2001-2005 at the 160 m station and average abundances have remained low since 2005.

3) Investigation of longitudinal trends in Nopili indicate that there were more Nopili within 100 m of the mouth as compared to stations further upstream in 2005, 2006, and 2007.

4) The average abundance of Nopili near the mouth increased from 2005 (~3 fish) to 2006 (~8 fish) and 2007 (~20 fish).

Appendix 16: Database User's Guide

Introduction

The Stream Monitoring database is the main storage location for all data related to the Stream Monitoring protocol. It requires manual data entry for entering survey information.

Database files will be distributed to the project manager at the beginning of the year to facilitate prompt data entry. At the end of the field season, files will be submitted to the PACN data management staff for consolidation into the master database file.

Installing the Stream Monitoring Database

The user can copy and paste both front and back end database files to a park server that has automatic backups. If some parks lack these resources, store the files on a local computer and employ a backup strategy, such as using an external hard drive. The database application contains a back up component, which is accessed from the main application Switchboard Form that opens automatically when the application starts (see "Back Up Data" below). This component can be programmed to automatically ask the user to create a back up when the database is opened for a data entry session. This will ensure that the initial data starting point can be recovered should irreversible errors or problems occur during the data entry session. Back-up copies are used for the current field season only and will not be archived. The database files should be stored in the appropriate I&M project folder (recommended directory structure: streams/database/backups).

To facilitate data entry, the front-end file should be copied to a local workstation if the database files are stored on a networked server. Opening and using the front-end on the network 'bloats' the database file and makes it run more slowly. In some cases, linking to the back-end on the server will cause the database to run very slowly. In these cases, the back-end file can also be copied to the local workstation. At the end of the day after data entry, the back end should be copied back to the server so that it will be backed up. Once these files are copied, users will need to re-link the front end databases to the correct back-end database file. *Important note*: Make sure the front-end database is linked to the correct back-end database. If the back-end was copied from the server onto a local workstation for data entry, the front-end database will be linked to the back-end on the server until the link is changed (see "Connect Data Tables" below).

Starting the Stream Monitoring Database

Double-click on streams_FE_v1.mdb to start the application.

Features of the Application Startup Form

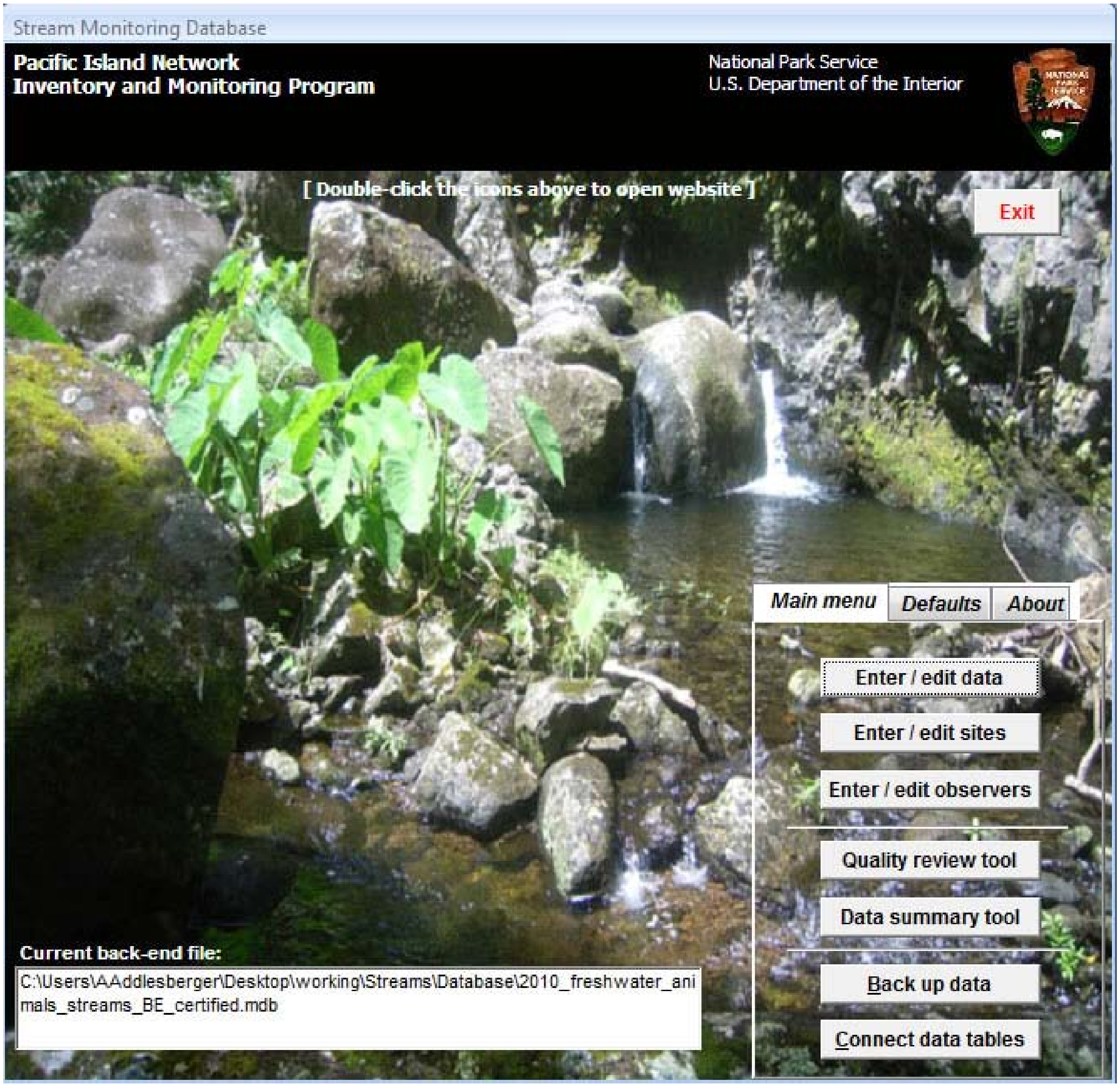
The Startup Form is the entry point for the application, and therefore the first thing users will usually see when opening the application.
Double-clicking "Pacific Island Network" at the top left of the form will open the web site for the Network. Double-clicking the NPS Arrowhead or the title National Park Service at the top right of the form will open a browser and navigate to the National Park Service web site (www.nps.gov).

Also at the top right of the form is an exit button which can be used to close the application. A tabbed menu resides at the lower right corner of the form. It contains tabs for the main menu, application defaults, and information about the application. Each of the tabs will be examined in more detail in the sections that follow.

At the bottom center-left of the form is a box that displays the current location of the data file to which the application is linked.

Main Menu

The main menu of the application is what users will see when the application is started. It provides buttons for entering/editing data and survey sites, entering/editing observers, quality review checks, data summarization, backing up data, and connecting data tables.



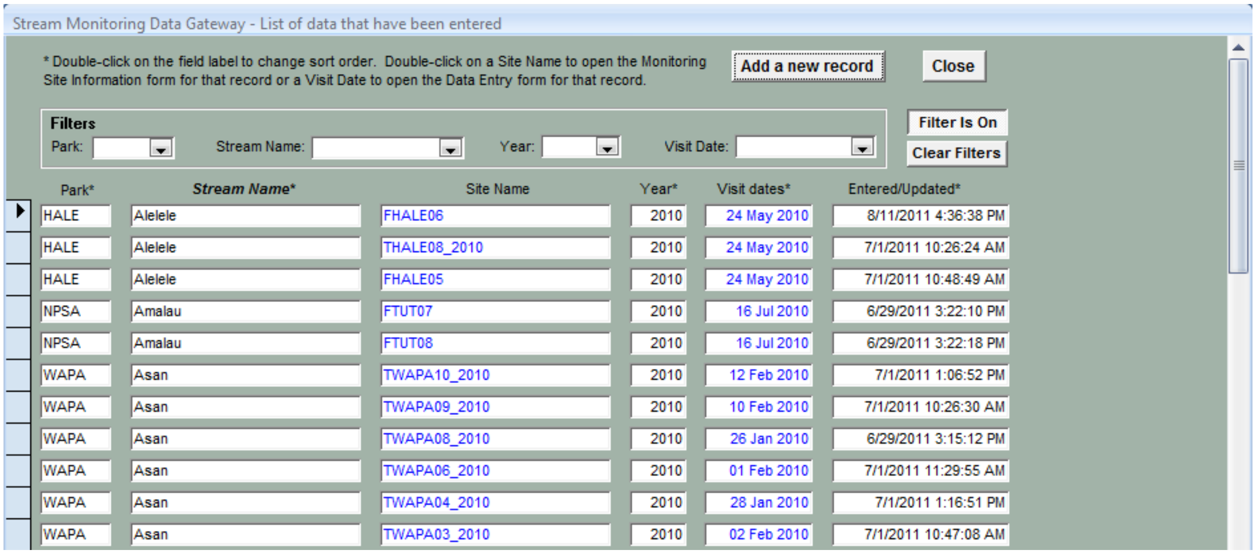
Main Menu

Enter/Edit Data

Clicking the Enter/edit data button will open the Data Gateway Form.

Data Gateway Form

This form displays location and event information for each record, and is designed to help the user determine which record to edit/view.


Stream Monitoring Data Gateway - List of data that have been entered

* Double-click on the field label to change sort order. Double-click on a Site Name to open the Monitoring Site Information form for that record or a Visit Date to open the Data Entry form for that record.

Add a new record | Close

Filters
Park: | Stream Name: | Year: | Visit Date:

Filter Is On | Clear Filters

Park*	Stream Name*	Site Name	Year*	Visit dates*	Entered/Updated*
HALE	Alelele	FHALE06	2010	24 May 2010	8/11/2011 4:36:38 PM
HALE	Alelele	THALE08_2010	2010	24 May 2010	7/1/2011 10:26:24 AM
HALE	Alelele	FHALE05	2010	24 May 2010	7/1/2011 10:48:49 AM
NPSA	Amalau	FTUT07	2010	16 Jul 2010	6/29/2011 3:22:10 PM
NPSA	Amalau	FTUT08	2010	16 Jul 2010	6/29/2011 3:22:18 PM
WAPA	Asan	TWAPA10_2010	2010	12 Feb 2010	7/1/2011 1:06:52 PM
WAPA	Asan	TWAPA09_2010	2010	10 Feb 2010	7/1/2011 10:26:30 AM
WAPA	Asan	TWAPA08_2010	2010	26 Jan 2010	6/29/2011 3:15:12 PM
WAPA	Asan	TWAPA06_2010	2010	01 Feb 2010	7/1/2011 11:29:55 AM
WAPA	Asan	TWAPA04_2010	2010	28 Jan 2010	7/1/2011 1:16:51 PM
WAPA	Asan	TWAPA03_2010	2010	02 Feb 2010	7/1/2011 10:47:08 AM

Data Gateway Form

Filters for Park, Stream Name, Year, and Visit Date can be set by selecting from the drop-down lists at the top of the form in the Filters box. Filters facilitate finding surveys for certain stream names; the user will not have to scroll through all records to find the survey they are looking for. Filters can be removed by clicking the toggle button that says “Filter Is On”. It will toggle up and say “Filter Is Off” when the filter is removed. When the filter is removed, all records will be displayed. Optionally, a specific filter can be removed by deleting the text that is currently displayed in one of the filter controls.

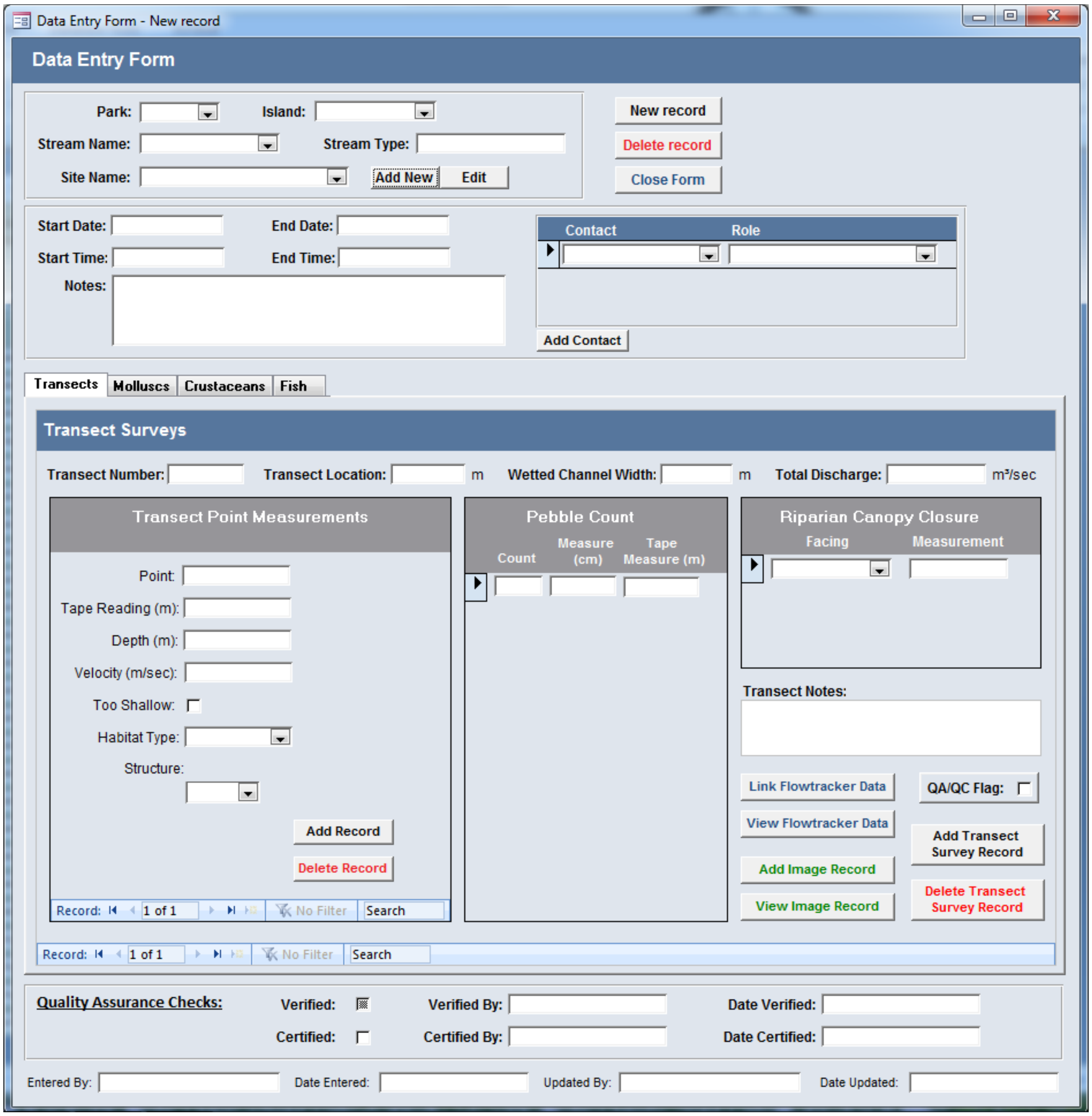
In addition to filters, there are sorting options for the records on the Data Gateway Form. Double-clicking any of the column headings will cause the records to be sorted in ascending order by that column value. The column heading will change to a bold italic format to indicate that it is the column being used to determine sort order. If the same column is double-clicked a second time, the records will be sorted in descending order by that column value.

Double-clicking a Site Name value will open the Monitoring Site Information Form for that particular record’s Park and Survey Area (see the Monitoring Site Information Form section that follows). Double-clicking a Visit Date will open the Data Entry Form (includes Event data; see the Data Entry Form section below) for that particular record.

To add a new data entry record, click the “Add a new record” button at the top of the Data Gateway Form.

Data Entry Form

The Data Entry Form is used to select/enter a location (Park, Island, Stream Name, Stream Type, and Site Name), start date, end date, start time, end time, notes, contact information, survey data, and quality assurance checks.

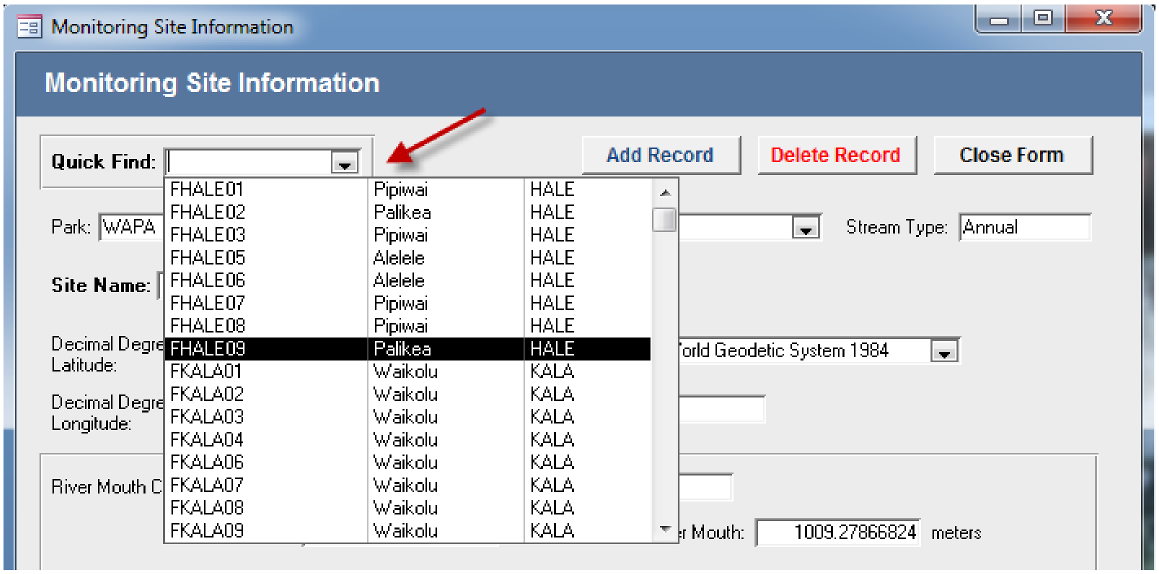


Data Entry Form

Select a Park from the drop down list. The Island field will be automatically populated based on your selected Park (does not apply to NPSA; user must choose an island for NPSA). Stream Names for the selected Park and Island will be available from the drop down list. Stream Type will also be automatically populated once a Stream Name has been selected. After choosing a Stream, existing Site Names will be available from the drop down list. To add or edit a Monitoring Site, click the “Add New” or “Edit” buttons (see “Monitoring Site Information Form” below).

After filling in location information, enter a start date, end date, start time, end time, event notes, and contact information. The start date and end date must be entered using a month/day/year format (ex: 5/30/2009). The start time and end time must be entered using an hour/minute format (ex: 11:45). The user will not be able to enter these items until all of the location information has been entered. At any time in the data entry process, the buttons located at the top of the page may be used to go to a new record, delete the current record, or close the form.

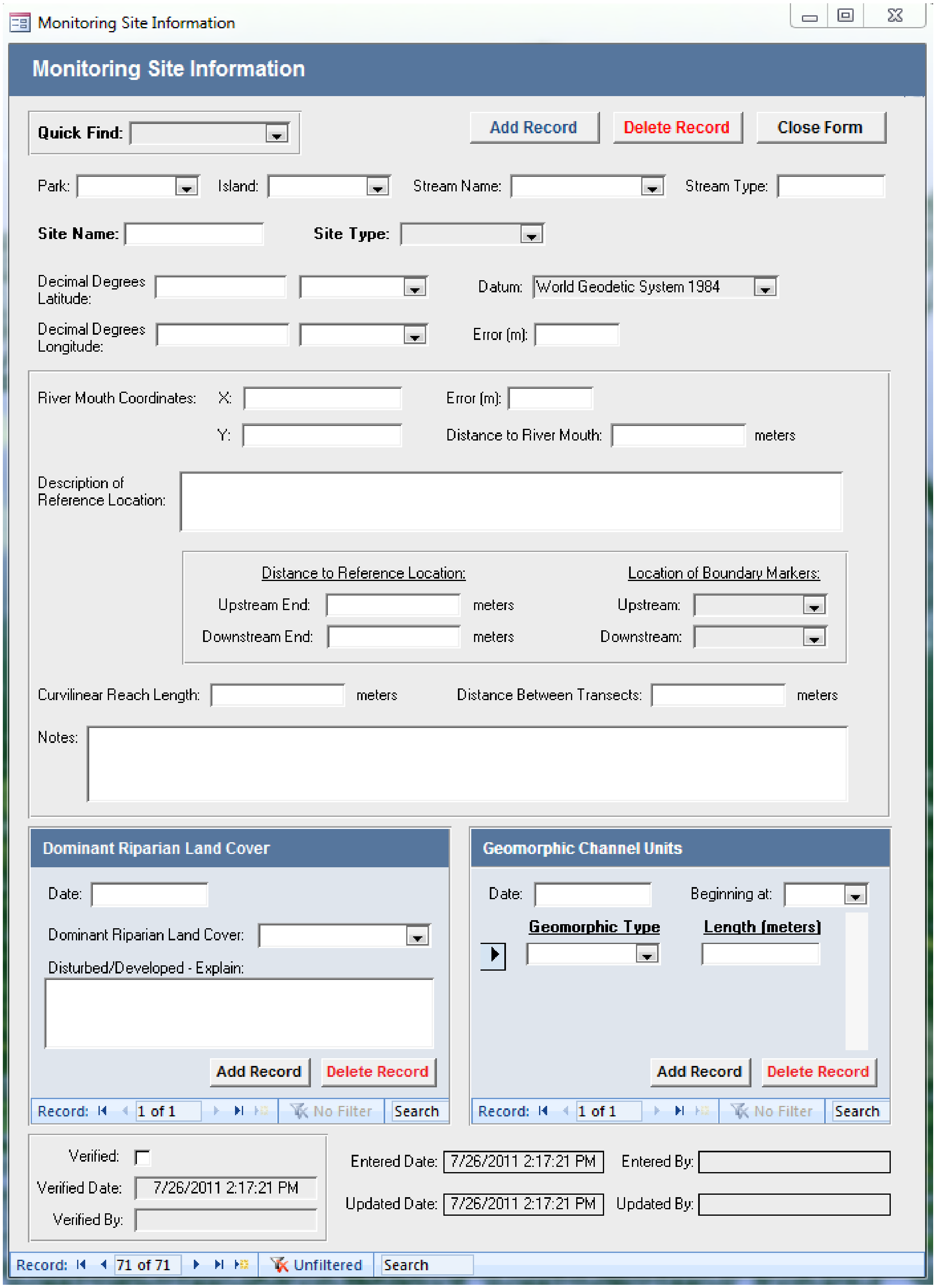
Monitoring Site Information Form
To enter a new monitoring site, click the "Add New" button located on the Data Entry Form or the "Enter/edit sites" button from the Main Menu. To edit an existing monitoring site from the Data Entry Form, select a Site Name from the drop down list and click the "Edit" button. The Monitoring Site Information Form will open. To edit an existing monitoring site from the Main Menu, click the "Enter/edit sites" button and use the Quick Find drop down menu to find a site.



Values entered on this form include:

- Park
- Island
- Stream Name
- Stream Type
- Site Name
- Site Type
- Site Coordinates
    - Decimal Degrees Latitude
    - Decimal Degrees Longitude
    - Datum
    - Error (m)

- Coordinates of River Mouth
    - X
    - Y
    - Error (m)
- Distance to River Mouth
- Description of Reference Location
- Distance to Reference Location
    - Upstream End
    - Downstream End
- Location of Boundary Markers
    - Upstream
    - Downstream
- Curvilinear Reach Length
- Distance Between Transects
- Notes
- Dominant Riparian Land Cover
    - Date
    - Dominant Riparian Land Cover
    - Disturbed/Developed – Explain
- Geomorphic Channel Units
    - Date
    - Beginning at
    - Geomorphic Type
    - Length (meters)
- Entered Date
- Entered By
- Updated Date
- Updated By
- Verified
- Verified Date
- Verified By


Monitoring Site Information

Monitoring Site Information

Quick Find:

Add Record
Delete Record
Close Form

Park:
Island:
Stream Name:
Stream Type:

Site Name:
Site Type:

Decimal Degrees Latitude:
Datum: World Geodetic System 1984

Decimal Degrees Longitude:
Error (m):

River Mouth Coordinates: X:
Error (m):
Y:
Distance to River Mouth: meters

Description of Reference Location:

Distance to Reference Location:
Upstream End: meters
Downstream End: meters

Location of Boundary Markers:
Upstream:
Downstream:

Curvilinear Reach Length: meters
Distance Between Transects: meters

Notes:

Dominant Riparian Land Cover

Date:
Dominant Riparian Land Cover:
Disturbed/Developed - Explain:

Add Record
Delete Record

Record: 1 of 1 No Filter Search

Geomorphic Channel Units

Date:
Beginning at:

Geomorphic Type
Length (meters)

Add Record
Delete Record

Record: 1 of 1 No Filter Search

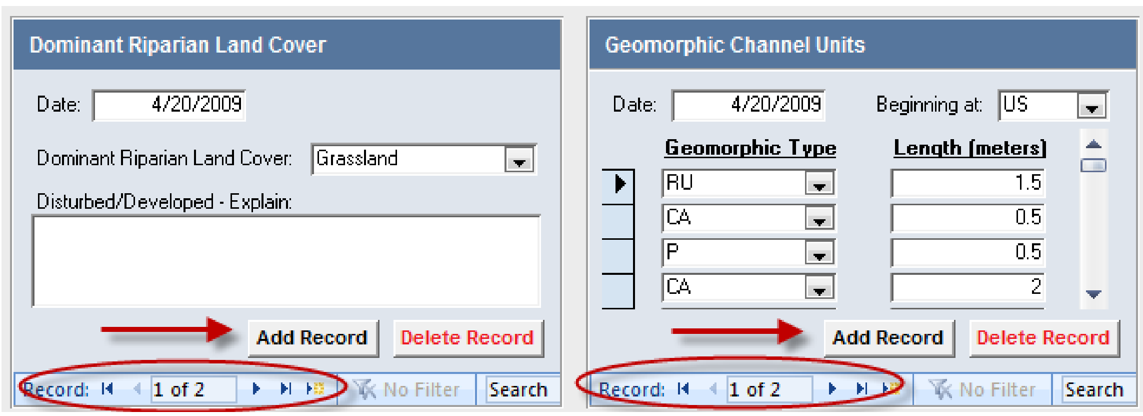
Verified:
Verified Date: 7/26/2011 2:17:21 PM
Verified By:

Entered Date: 7/26/2011 2:17:21 PM
Entered By:
Updated Date: 7/26/2011 2:17:21 PM
Updated By:

Record: 71 of 71 Unfiltered Search

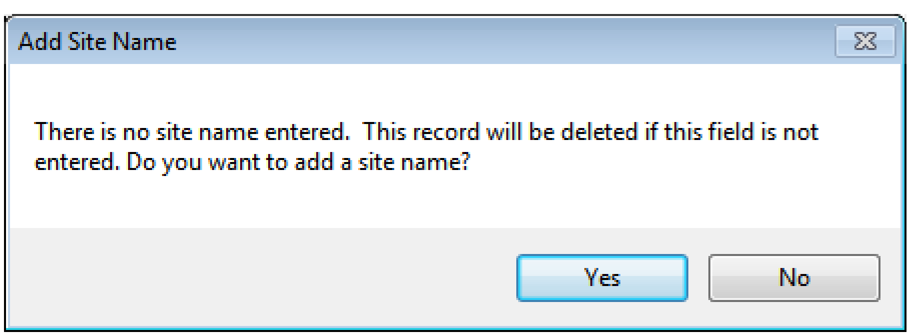
Monitoring Site Information Form

Park, Island, Stream Name, Stream Type, Datum, and UTM Zone will be automatically filled in based on the information entered in the Data Entry Form. If the Monitoring Site Information Form was accessed using the Main Menu then these fields will need to be filled in. Dominant Riparian Land Cover and Geomorphic Channel Units should be recorded annually for each site (or as often as sites are monitored). This will help track changes over time that may occur at individual sites. To add a new Dominant Riparian Land Cover or Geomorphic Channel Units record to a site click the "Add Record" button. To delete a record, click the "Delete Record" button. The scroll buttons on the bottom can be used to view existing records. In addition, once Geomorphic Type has reached a total length of 30 meters, no additional records will be accepted.



The Entered Date, Entered By, Updated Date, and Updated By fields are automatically populated when a record is created or updated. Once all fields have been filled in, the data should be verified. If a site has been verified the check box next to "Verified" should be marked, and the "Verified By" and "Date Verified" fields should be completed; these fields are not automatically populated.

To add or delete a monitoring site record, use the buttons located at the top of the form. The "Close Form" button will save the site record and return you to the Data Entry Form. A site name must be entered in order to save the site record. If this field is not filled in a message box will appear. If no site name is entered, then the record will be deleted.


Add Site Name

There is no site name entered. This record will be deleted if this field is not entered. Do you want to add a site name?

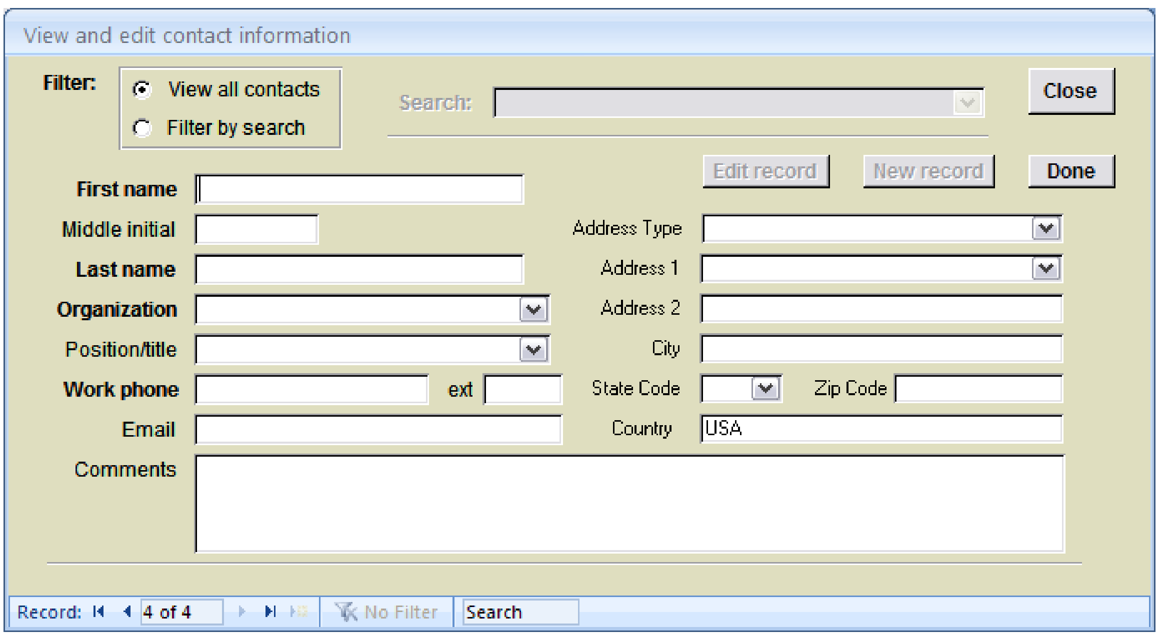
Yes No

Contacts Form

To enter a new Contact from the Main Data Entry Form, click "Add Contact". The View and Edit Contact Information Form will open. This is where new contact information is entered. This form can also be accessed from the main menu by clicking on the Enter/Edit Observers button. Values entered here include:

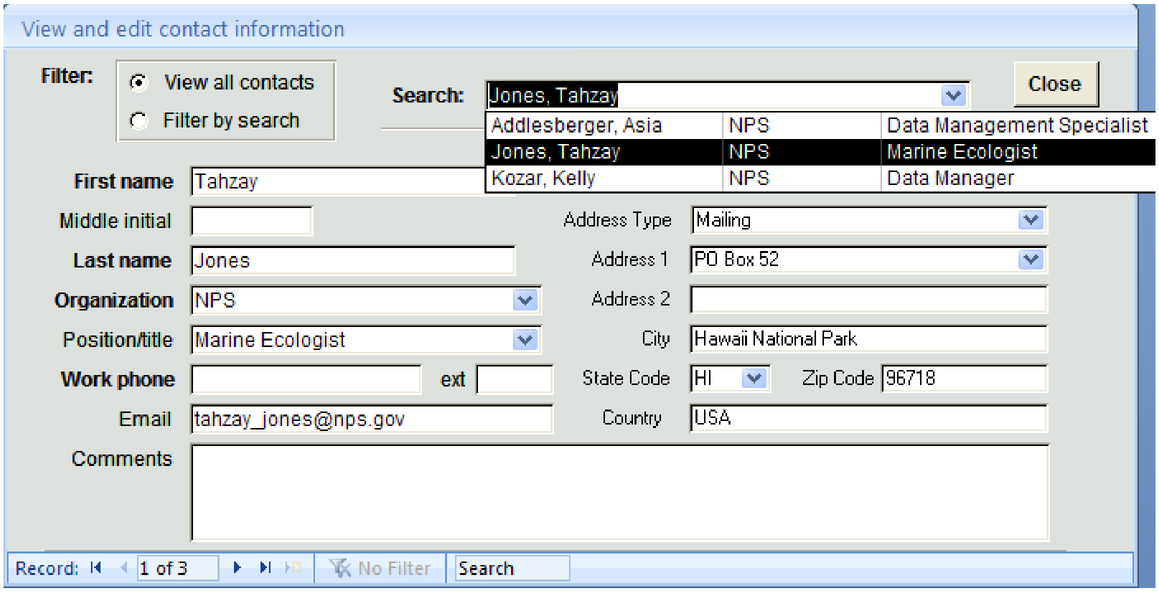
- First Name, Middle Initial, Last Name
- Organization
- Position/title
- Work Phone and Extension
- Email Address
- Address Information, including Address Type, Street Address, City, State, Zip Code, and Country
- Comments

Previously entered addresses can be selected from the Address 1 drop-down list, and the associated Street Address, City, State, Zip, and Country values will automatically be filled in. The Organization and Position/Title drop-down lists will also allow selection from previously entered values or new entries.



Contact Information Form (new record)

When the Contact Information Form is in view mode (grey background), individual contacts can be shown by selecting from the Search drop-down list at the top right of the form.



Contact Information Form (view mode)

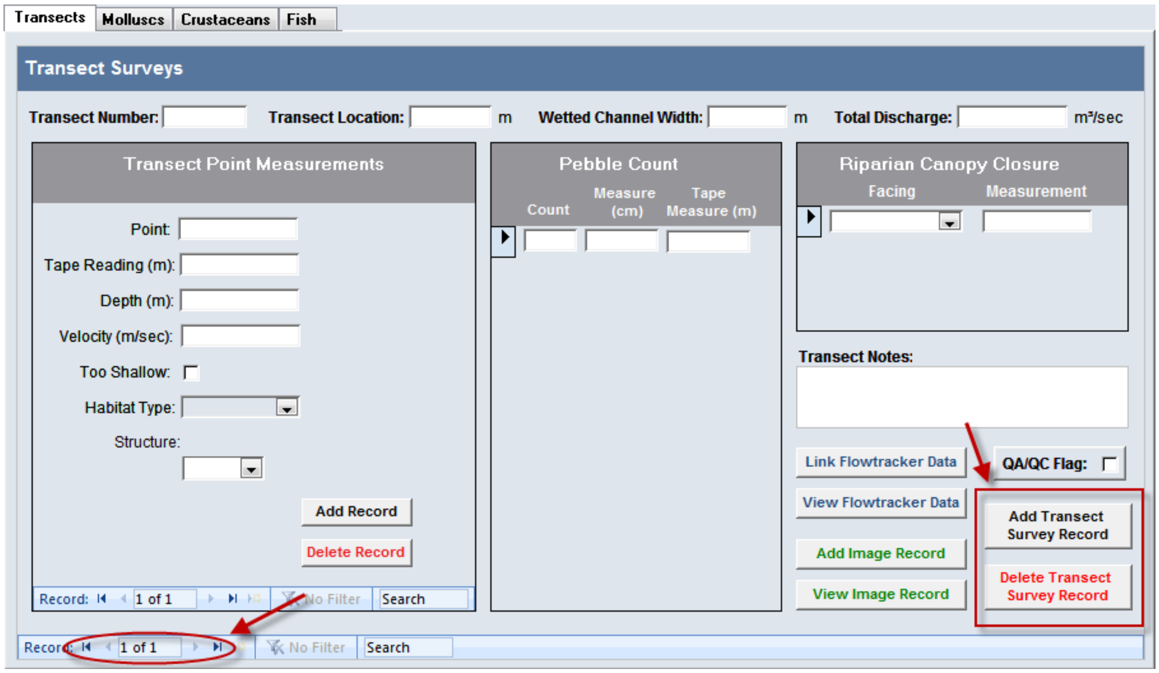
In view mode, records can only be read, not edited. To enable editing for a record, click the Edit record button.

Transect Surveys Sub-Form

The Transect Surveys Sub-Form is used to enter transect characterization information for transect surveys in a sampling event. This sub-form is embedded in the Data Entry Form and values entered here include:

- Transect Number
- Transect Location (m)
- Wetted Channel Width (m)
- Total Discharge (m^3/sec)
- QA/QC Flag
- Transect Point Measurements
    - Point
    - Tape Reading (m)
    - Depth (m)
    - Velocity (m/sec)
    - Too Shallow
    - Habitat Type
    - Structure
- Pebble Count
    - Count
    - Measure (cm)
    - Tape Measure (m)

- Riparian Canopy Closure
  - Facing
  - Measurement



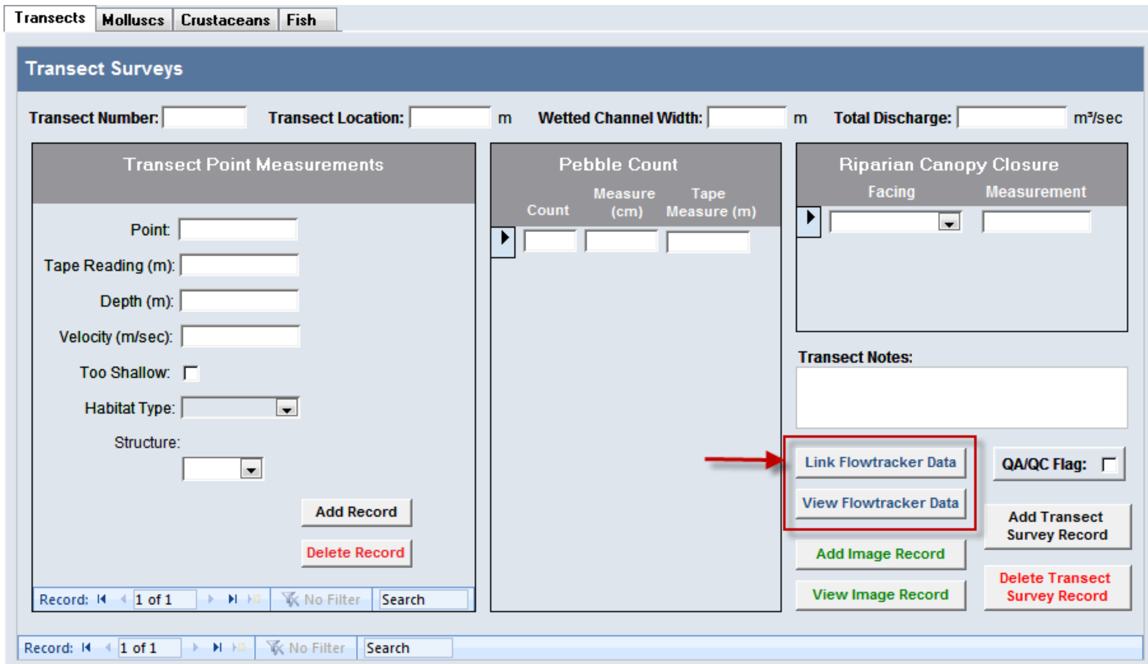
Transect Survey Sub-Form

Once a transect number, transect location, wetted channel width, and total discharge has been entered, data should be filled in for Transect Point Measurements, Pebble Counts, and Riparian Canopy Closure. If a transect number is not entered, these fields will remained locked. To add additional transect records, click the “Add Transect Survey Record” button, or use the scroll buttons on the bottom left; to delete a transect record, click the “Delete Transect Survey Record” button.

Tape Reading, Depth, Velocity, Habitat Type, and Structure should be recorded for transect point measurements 1, 2, 3, 4, 5, LEW, and REW. To add or delete a transect point measurement record, click the buttons located at the bottom right of the Transect Point Measurements section. Total Discharge (located at the top of the Transect Survey Form) applies to Transect Point Measurements only and should be filled in with the correct discharge number or NA. Pebble count measurements should measure the b-axis diameter of 20 rocks and provide an accurate tape measurement in meters. Riparian canopy closure measurements should be taken facing the left, center and right bank of each stream. If a stream is less than one meter wide, only a center measurement should be recorded.

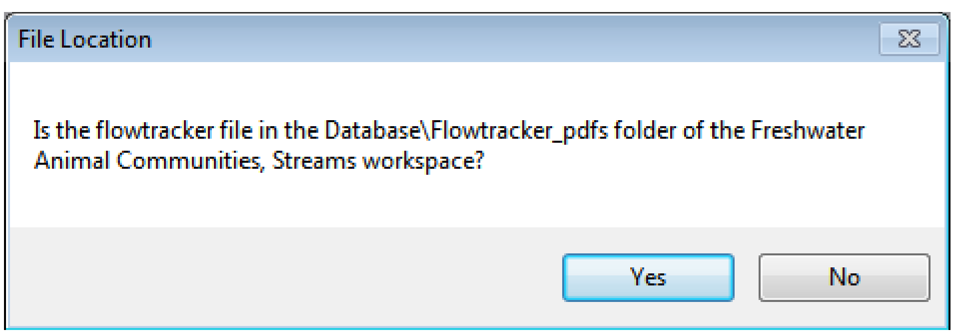
If during the transect survey the stream reach is dry, a 0 (zero) should be entered in the following fields: Wetted Channel Width, Total Discharge, and Depth (Transect Point Measurements section). It should also be recorded in the Transect Notes section that the stream reach was dry. The QA/QC Flag checkbox is used to indicate the transect record has been flagged for further review.

If flowtracker data is available (as a .pdf), it can be linked to the transect survey by clicking the "Link Flowtracker Data" button.

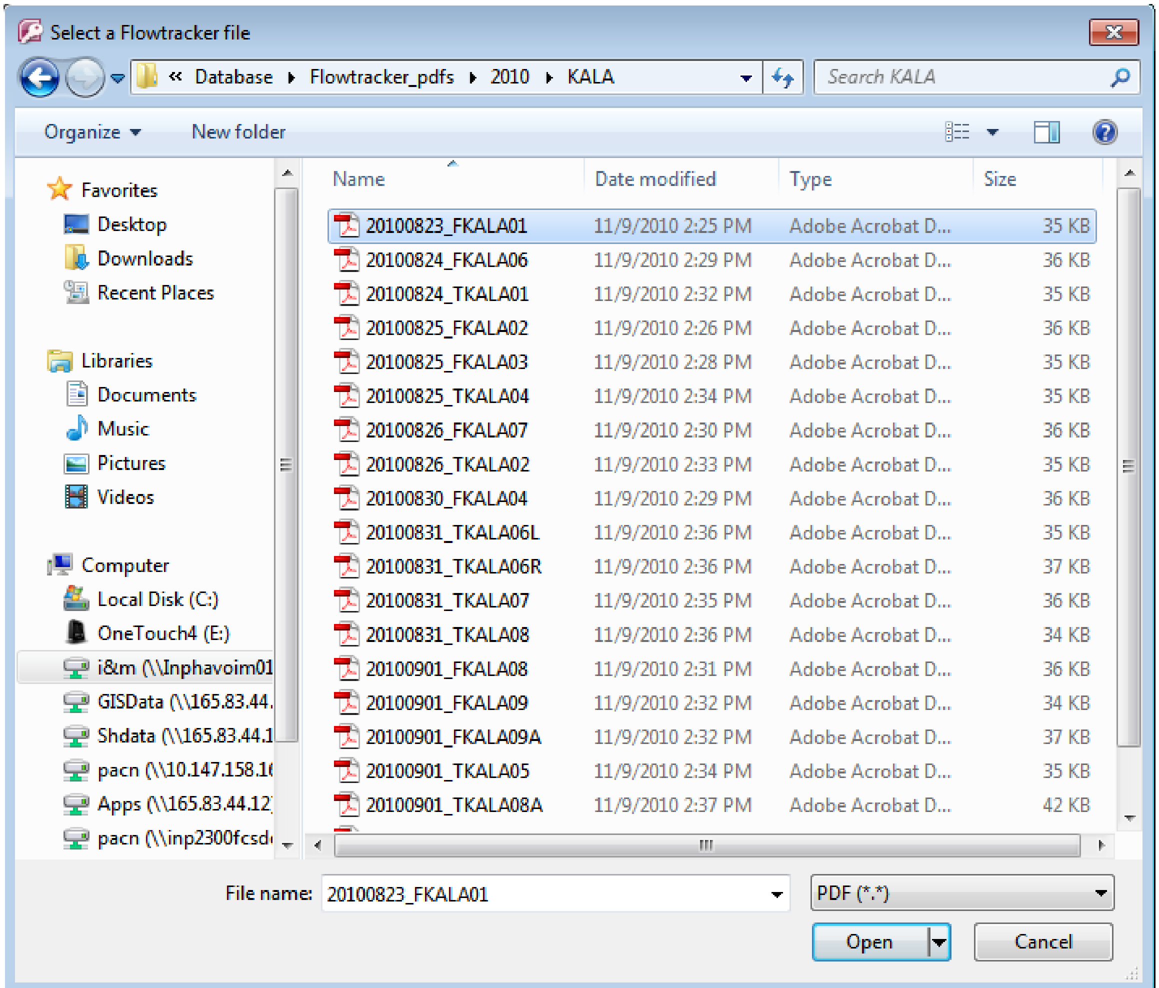


Transect Survey Sub-Form

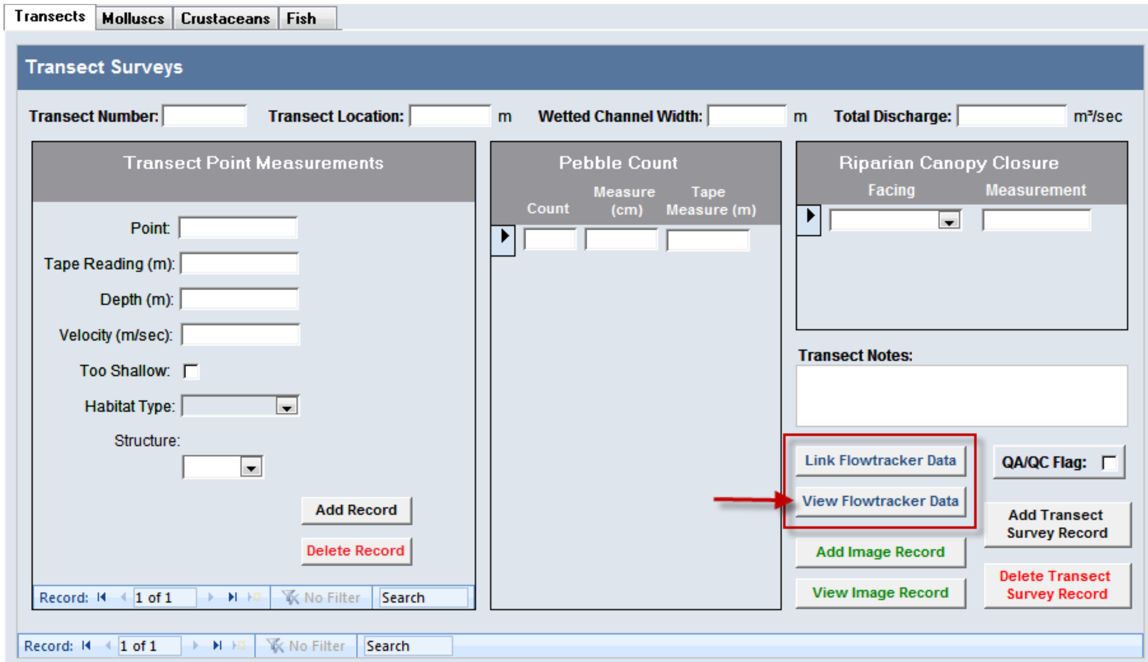
The following dialog box will open. If the flowtracker .pdf file is in the correct location click "Yes." If it is not in the correct location click "No", this will close the dialog box. Use windows explorer to move the flowtracker .pdf to the appropriate folder before trying to re-link the file again. In order for the links to work properly in the database, this folder structure must be maintained.



Once the flowtracker .pdf is in the proper folder location and the "Yes" button is clicked, navigate to the correct .pdf file and click "Open." This will automatically link it to the transect survey. Only one flowtracker .pdf may be linked to each transect survey.

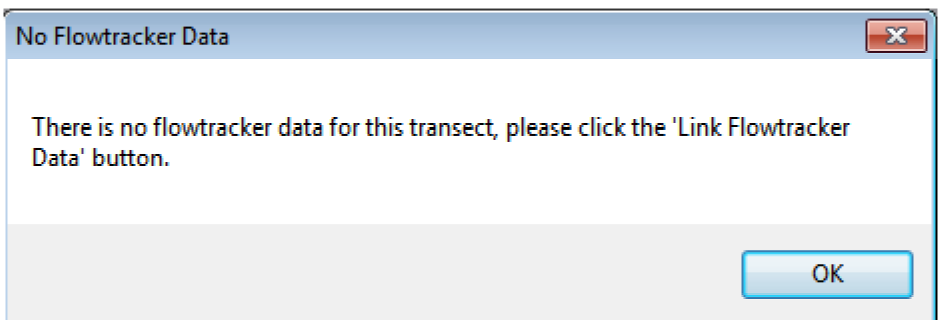


If there is flowtracker data already linked to a transect, it may be viewed by clicking the "View Flowtracker Data" button.



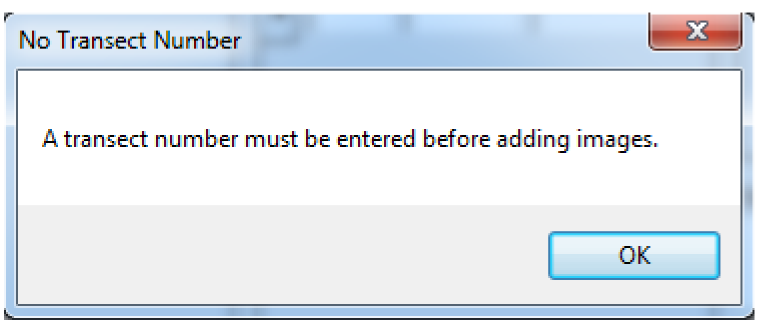
Transect Survey Sub-Form

This will open up the flowtracker .pdf file in a separate window. If there is no data for that transect, a message box will appear.

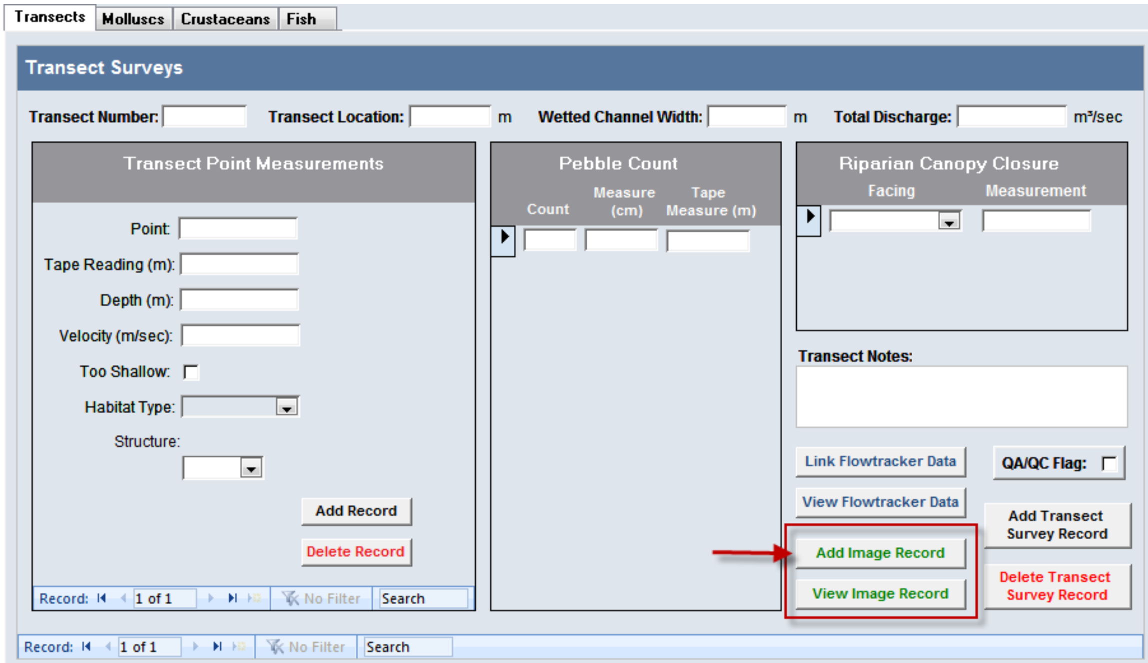


Transect Survey Image Form

In order to link images to a transect survey, the Transect Number must be filled in. If a Transect Number has not been entered a message box will appear.



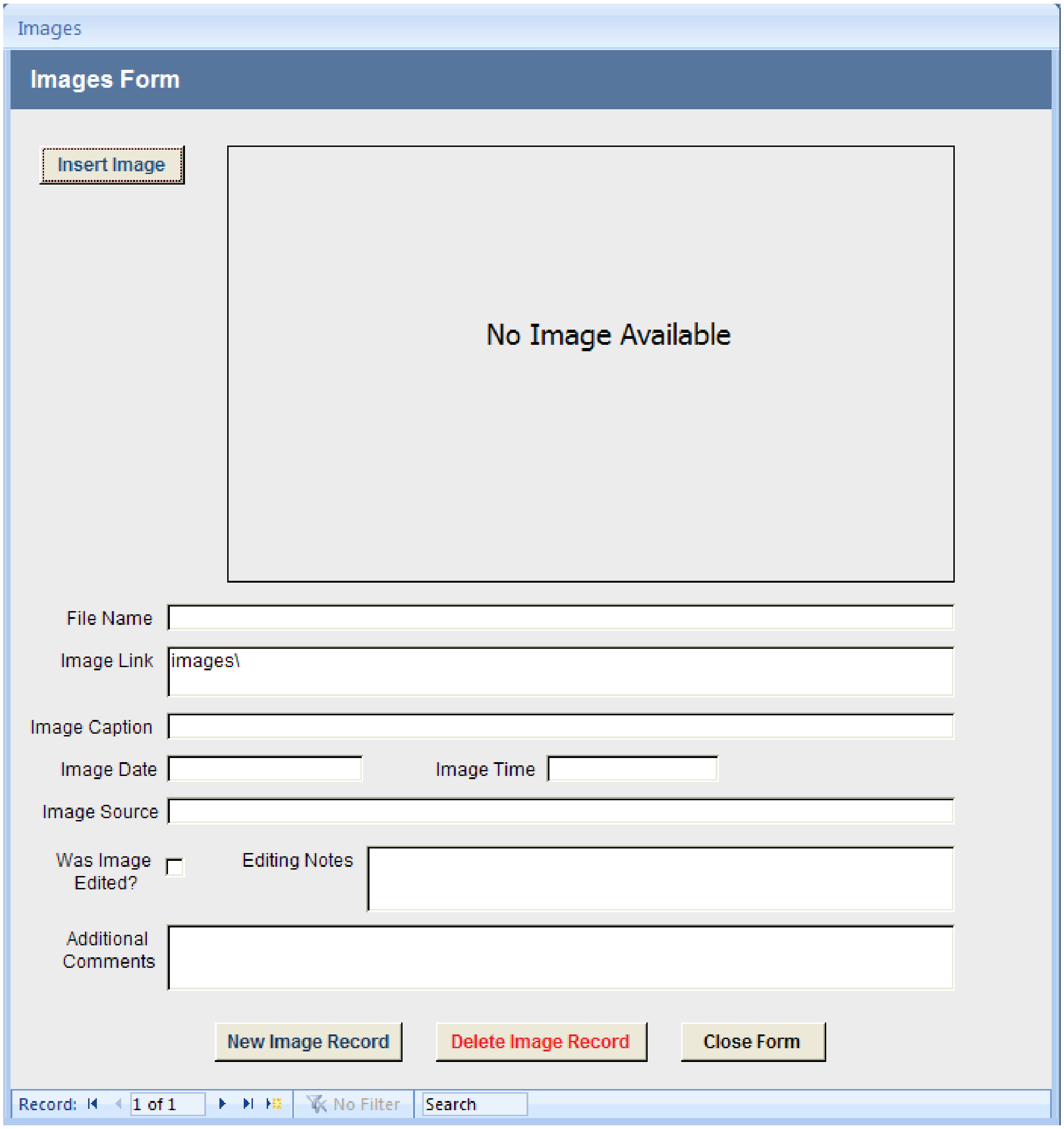
To add image records to a Transect click the "Add Image Record" button. A blank Images Form will open.



Transect Survey Sub-Form

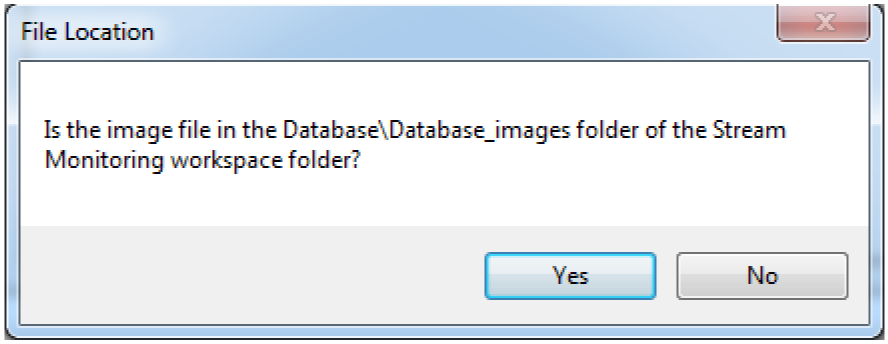
Values entered here include:

- File Name
- Image Link
- Image Caption
- Image Date
- Image Time
- Image Source
- Image Quality
- Was Image Edited? (Yes or No)
- Editing Notes
- Additional Comments



Images Form

To link an image to the record, click the “Insert Image” button in the top left hand corner. If the image file is in the correct location click “Yes.” If it is not in the correct location click “No”, this will close the dialog box. Use windows explorer to move the image file to the appropriate folder before trying to re-link the file again. In order for the links to work properly in the database, this folder structure must be maintained.



Once the image file is in the proper folder location and the "Yes" button is clicked, navigate to the correct image and click "Open." The image will be linked, and the File Name and Image Link fields will be automatically populated. This information is taken from the image file name that is chosen in the dialog box. There is no limit to the number of images that may be linked to a Transect. To add additional images to a Transect Survey select "New Image Record." To delete an Image record or close the Image Form use the control buttons located at the bottom of the page.

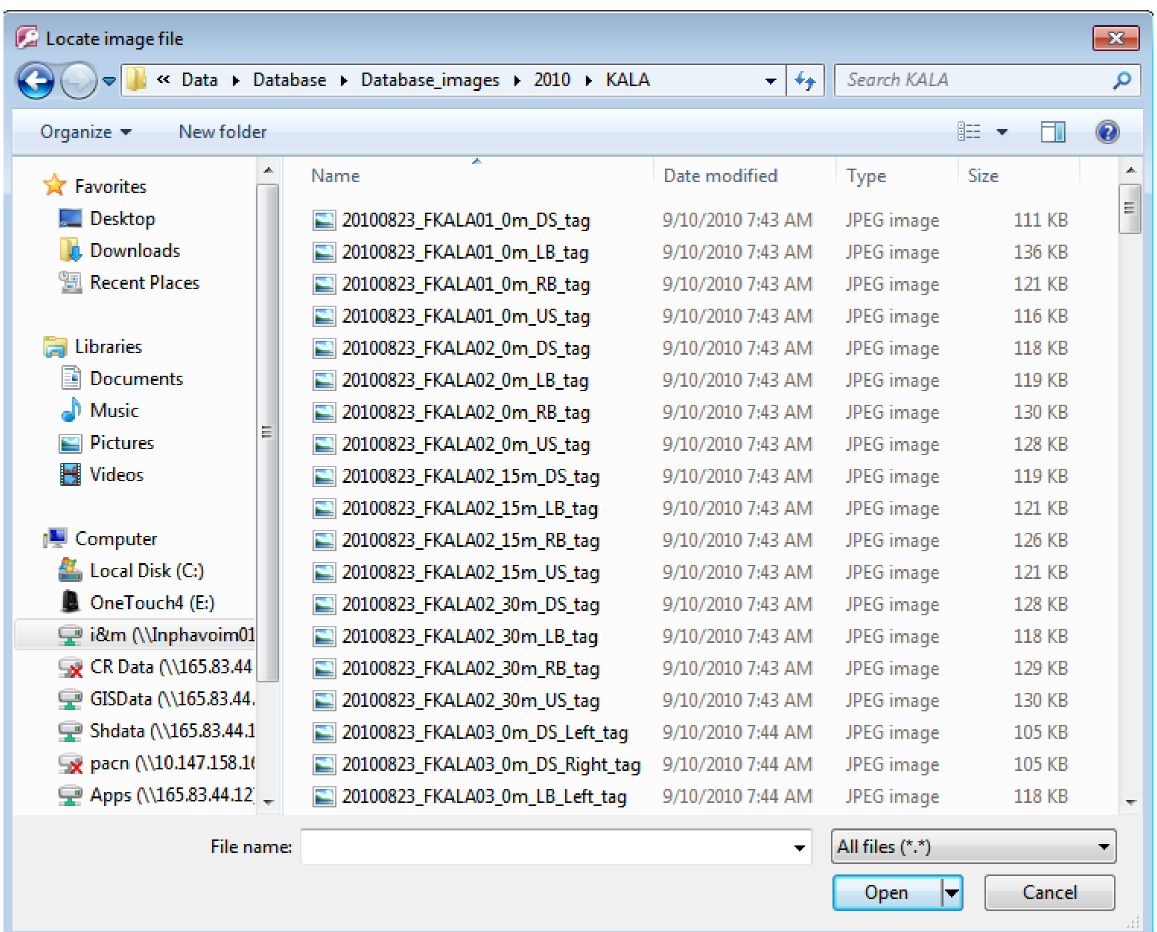
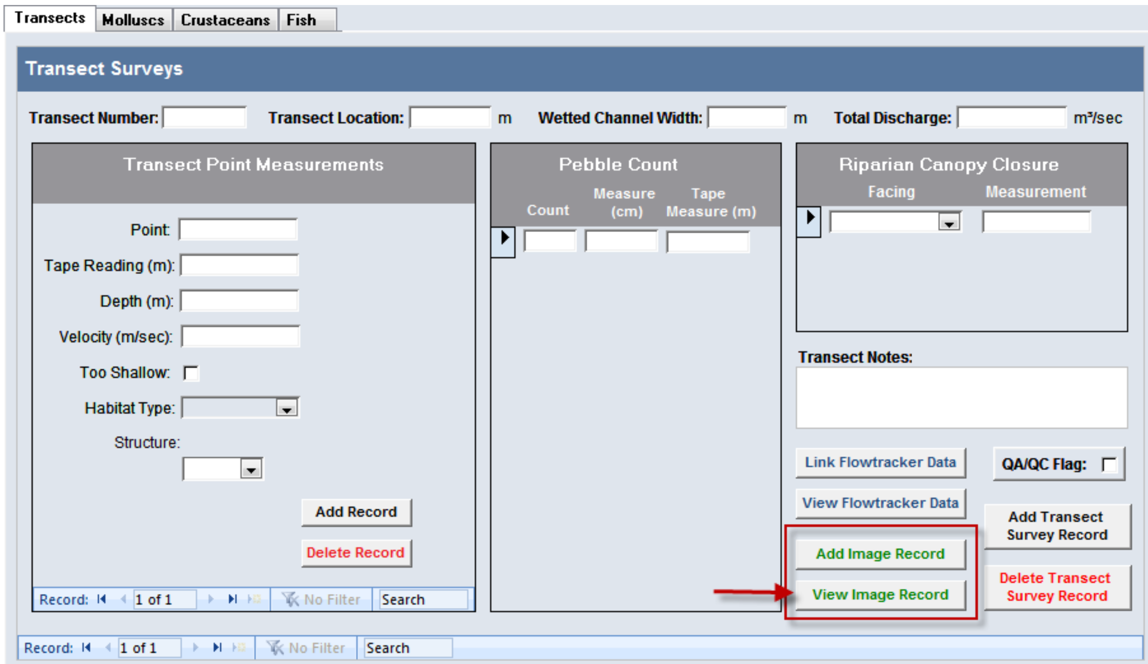
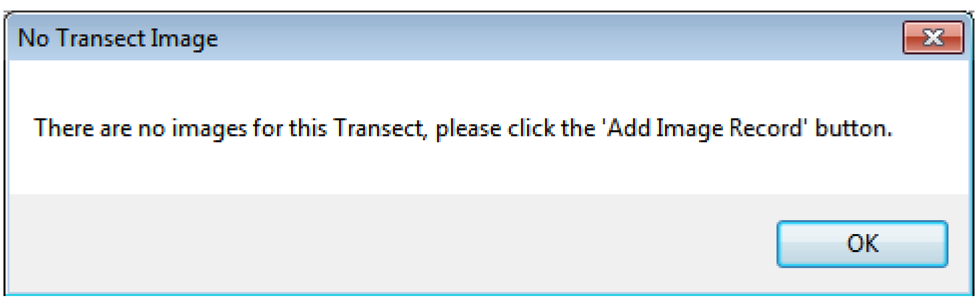


Image Dialog Box

If an image is already linked to a transect, it may be viewed by clicking the "View Image Record" button. If there are no images for that Transect record, a message box will appear.



Transect Survey Sub-Form

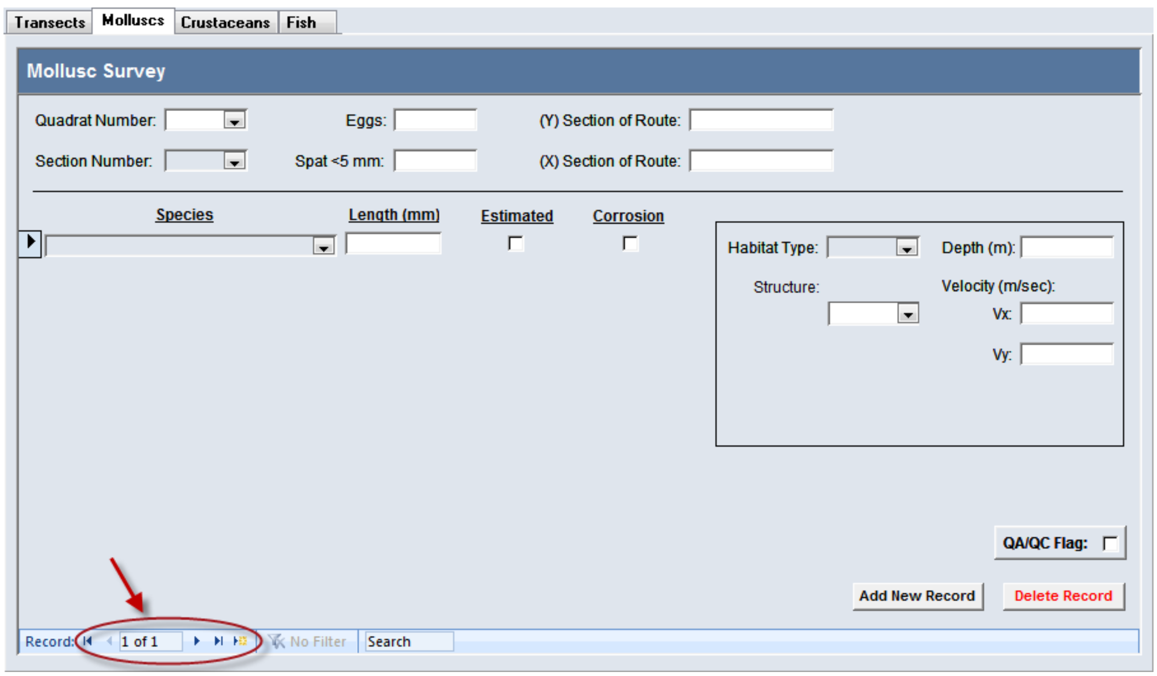


Mollusc Survey Sub-Form

The Mollusc Survey Sub-Form is used to enter information for mollusc surveys in a sampling event. This sub-form is embedded in the Data Entry Form and values entered here include:

- Quadrat Number
- Section Number
- (X) Section of Route
- (Y) Section of Route
- Eggs
- Spat <5 mm
- Species

- Length (mm)
- Estimated
- Corrosion
- Habitat Type
- Structure
- Depth (m)
- VX (m/sec)
- VY (m/sec)
- QA/QC Flag

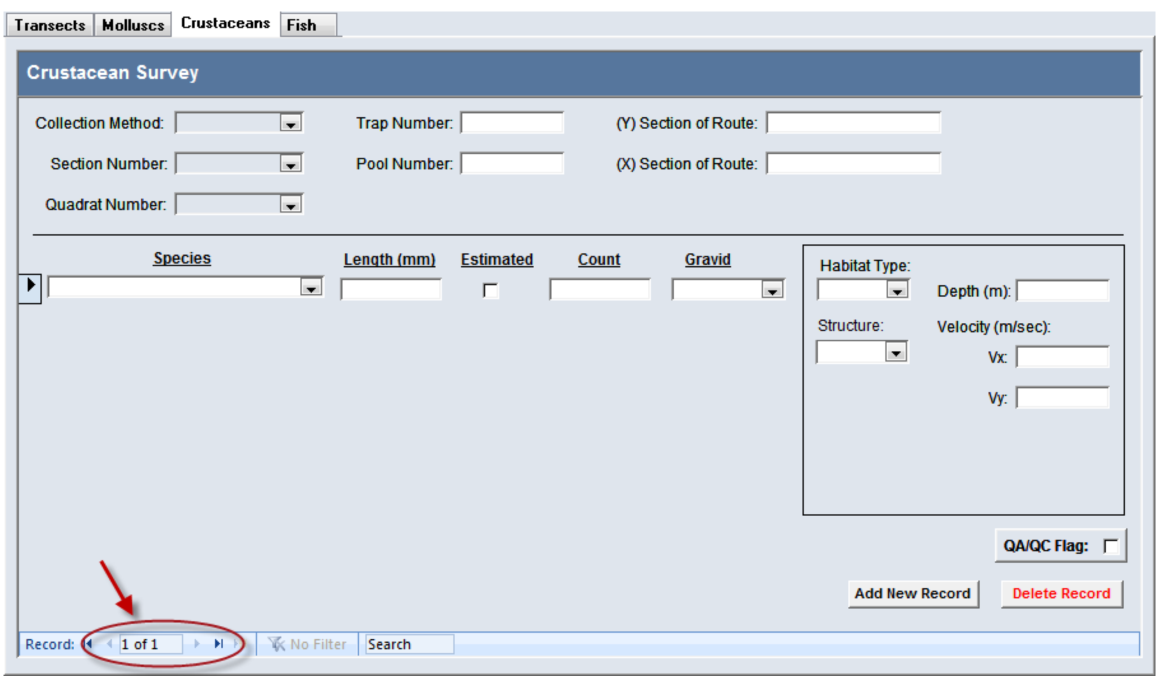


Mollusc Survey Sub-Form

A Quadrat or Section Number must be filled in before species can be entered. The Habitat Type, Structure, Depth, and Velocity are to be recorded for that specific Quadrat and/or Section and the QA/QC Flag checkbox is used to indicate the record has been flagged for further review.
To add additional mollusc survey records, click the “Add New Quadrat Record” button, or use the scroll buttons on the bottom left; to delete a mollusc survey record, click the “Delete Quadrat Record” button.

Crustacean Survey Sub-Form
The Crustacean Survey Sub-Form is used to enter information for crustacean surveys in a sampling event. This sub-form is embedded in the Data Entry Form and values entered here include:

- Collection Method
- Trap Number
- Section Number
- Pool Number
- Quadrat Number
- (X) Section of Route
- (Y) Section of Route
- Species
- Length (mm)
- Estimated
- Count
- Gravid
- Habitat Type
- Structure
- Depth (m)
- VX (m/sec)
- VY (m/sec)
- QA/QC Flag

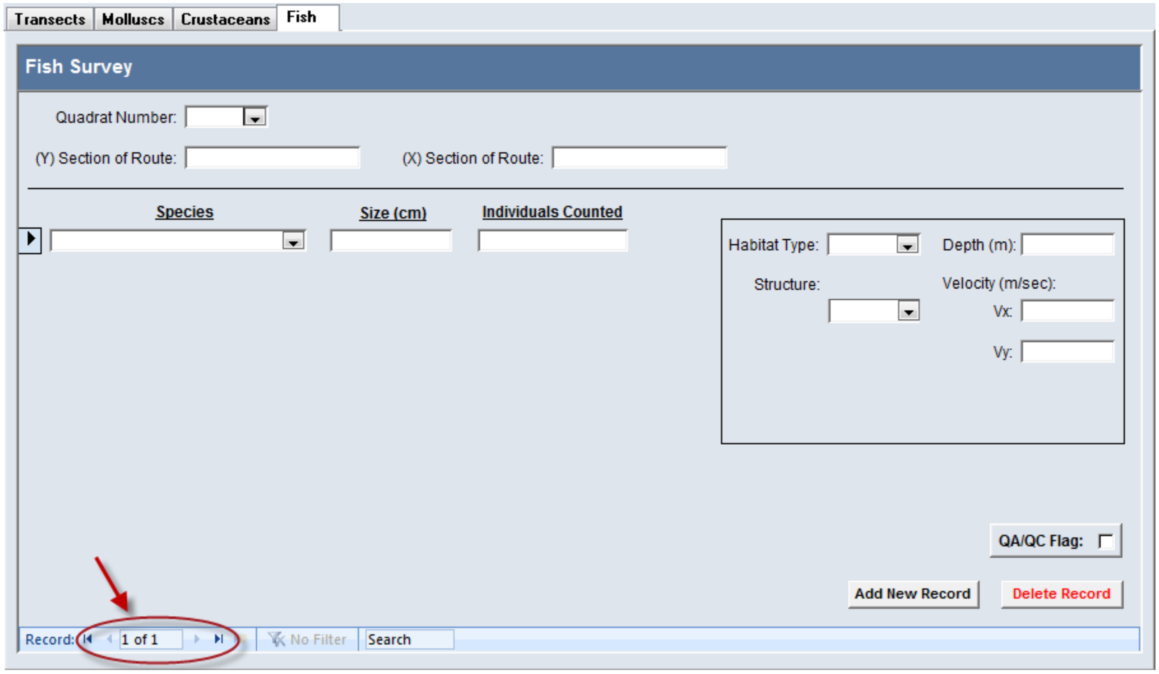


Crustacean Survey Sub-Form

A Quadrat or Section Number must be filled in before species can be entered. The Habitat Type, Structure, Depth, and Velocity are to be recorded for that specific Quadrat and/or Section and the QA/QC Flag checkbox is used to indicate the record has been flagged for further review.
To add additional crustacean survey records, click the "Add New Trap Record" button, or use the scroll buttons on the bottom left; to delete a crustacean survey record, click the "Delete Trap Record" button.

Fish Survey Sub-Form
The Fish Survey Sub-Form is used to enter information for fish surveys in a sampling event. This sub-form is embedded in the Data Entry Form and values entered here include:

- Quadrat Number
- (X) Section of Route
- (Y) Section of Route
- Species
- Size (cm)
- Individuals Counted
- Habitat Type
- Structure
- Depth (m)
- VX (m/sec)
- VY (m/sec)
- QA/QC Flag



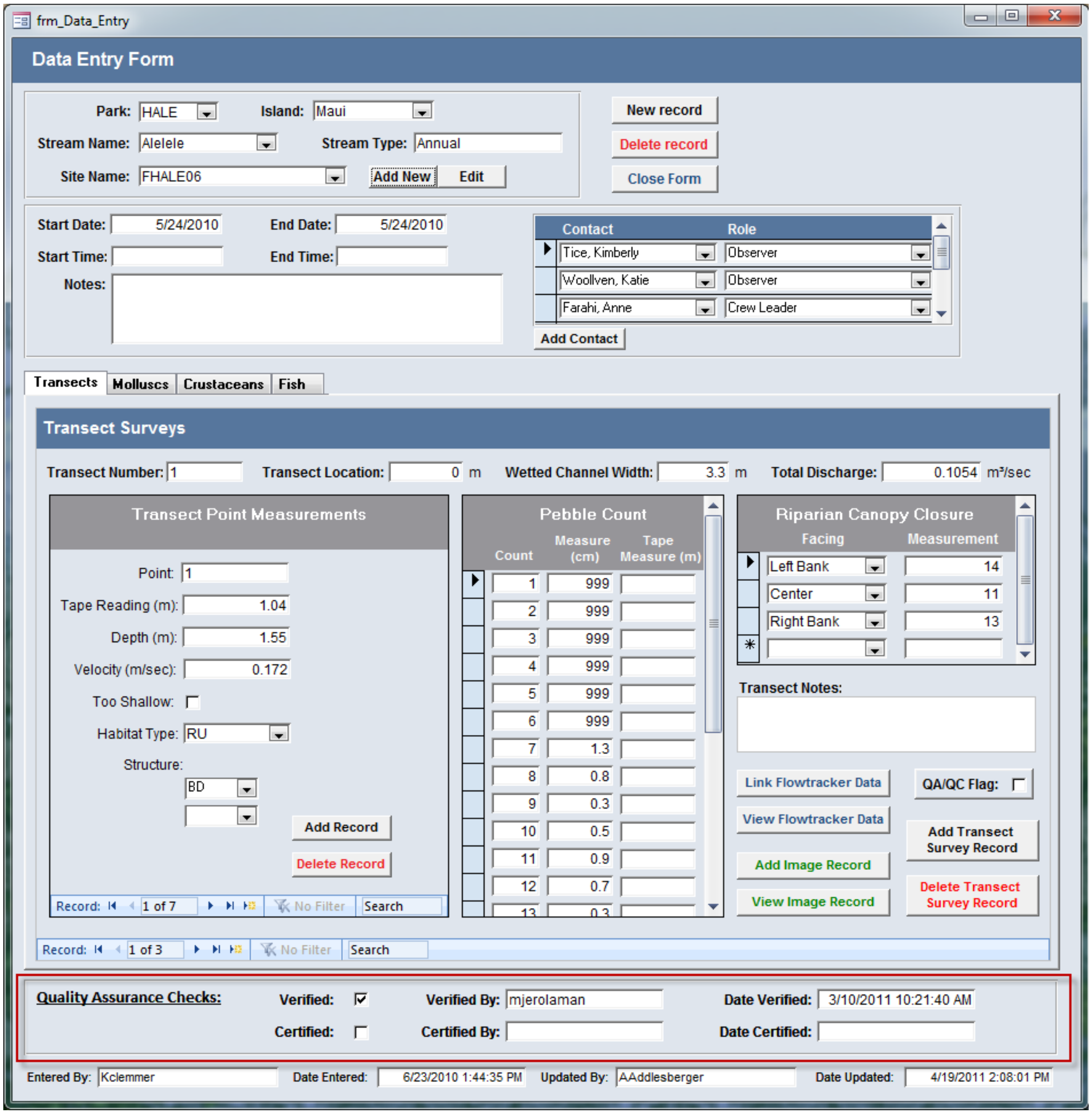
Fish Survey Sub-Form

A Quadrat Number must be filled in before species can be entered. The Habitat Type, Structure, Depth, and Velocity are to be recorded for that specific Quadrat and/or Section and the QA/QC Flag checkbox is used to indicate the record has been flagged for further review.

To add additional fish survey records, click the "Add New Quadrat Record" button, or use the scroll buttons on the bottom left; to delete a fish survey record, click the "Delete Quadrat Record" button.

Quality Assurance Checks

Once all fields and sub-forms on the Data Entry Form have been filled in, the data should be verified and then certified. If a record has been verified the check box next to "Verified" should be marked, and the "Verified By" and "Date Verified" fields should be completed; these fields are not automatically populated. Once a record has been certified, the check box next to "Certified" should be marked. The "Certified By" and "Date Certified" fields also need to be completed; these fields are not automatically populated.



Data Entry Form – Quality Assurance Checks Section

Enter/Edit Sites

The Monitoring Site Information Form may be opened from the Main Menu to add or edit monitoring sites. See the Monitoring Site Information Form above for details on how the form works.

Enter/Edit Observers

The Contact Form may be opened from the Main Menu to add or edit contact information. See the Contact Form above for details on how the form works.

Quality Review Tool

After the season's field data have been entered into the database, it will need to be reviewed and certified by the Project Lead for quality, completeness and logical consistency. The quality review tool contains queries that will help with the validation and certification of data in the working project database. These pre-built queries check for data integrity, data outliers and missing values, and illogical values. The user may then fix these problems and document the fixes.

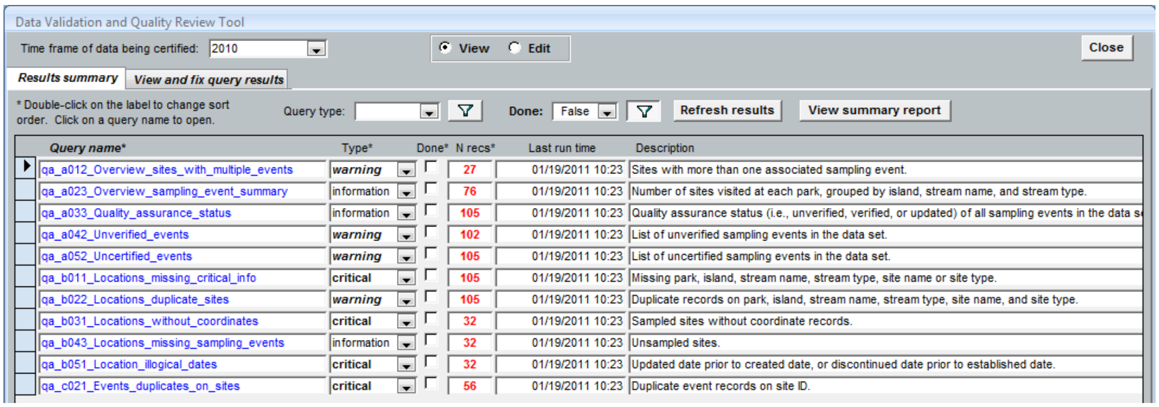
The following table shows the automated validation checks that are performed on the data prior to certification. These queries are designed to return records that need to be fixed, so ideally – once all data checks have been run and any errors have been fixed – none of the queries will return records. However, not all errors and inconsistencies can be fixed, in which case a description of the resulting errors and why edits were not made is then documented and included in the metadata and certification report.

The queries are named and numbered hierarchically so that high-order data should be fixed before low-order data. The rationale for this is that one change in a high-order table affects many downstream records, and so proceeding in this fashion is the most efficient way to isolate and treat errors.

Query_name	Returns records meeting the following criteria
qa_a012_Overview_sites_with_multiple_events	Sites with more than one associated sampling event
qa_a023_Overview_sampling_event_summary	Number of sites visited at each park, grouped by island, stream name, and stream type
qa_a033_Quality_assurance_status	Quality assurance status (i.e., unverified, verified, or updated) of all sampling events in the data set
qa_a042_Unverified_events	List of unverified sampling events in the data set
qa_a052_Uncertified_events	List of uncertified sampling events in the data set
qa_b011_Locations_missing_critical_info	Missing park, island, stream name, stream type, site name or site type
qa_b022_Locations_duplicate_sites	Duplicate records on park, island, stream name, stream type, site name, and site type
qa_b031_Locations_without_coordinates	Sampled sites without coordinate records
qa_b043_Locations_missing_sampling_events	Unsampled sites
qa_b051_Location_illogical_dates	Updated date prior to created date, or discontinued date prior to established date
qa_c011_Events_missing_critical_info	Sampling event records missing Site ID or start date
qa_c021_Events_duplicates_on_sites	Duplicate event records on site ID
qa_c032_Events_without_observers	Events without associated observers
qa_c042_Events_missing_QA_info	Event records without entered date/by entries, or incomplete updated date/by or verified date/by entries
qa_c051_Events_illogical_dates	Events with end dates prior to start date, or updated or verified dates prior to the record entry date
qa_d011_Transects_missing_critical_info	Transect surveys missing transect ID, transect number, transect location, wetted channel width, or total discharge
qa_d022_Transects_missing_point_measurements	Transect surveys missing point measurements
qa_d032_Transects_missing_pebble_counts	Transect surveys missing pebble counts
qa_d042_Transects_missing_riparian_canopy_closure	Transect surveys missing riparian canopy closure measurements
qa_d053_Transects_missing_images	Transect surveys missing images
qa_d063_Transects_missing_flowtracker_data	Transect surveys missing pdf links to flowtracker data
qa_e011_Molluscs_missing_species_length	Mollusc surveys missing species length
qa_e021_Molluscs_incorrect_species	Mollusc surveys with species chosen not found in park
qa_f011_Crustaceans_missing_species_length	Crustacean surveys missing species length
qa_f021_Crustaceans_missing_species_count	Crustacean surveys missing species count

Query_name	Returns records meeting the following criteria
qa_f031_Crustaceans_incorrect_species	Crustacean surveys with species chosen not found in park
qa_g011_Fish_missing_species_size	Fish surveys missing species size
qa_g021_Fish_missing_species_count	Fish surveys missing species count
qa_g031_Fish_incorrect_species	Fish surveys with species chosen not found in park

The quality review tool may be accessed from the Main Menu by clicking the Quality Review Tool button. The Data Validation and Quality Review Tool form will open and display existing records.


Data Validation and Quality Review Tool

Time frame of data being certified: 2010 | View | Edit | Close

Results summary | View and fix query results

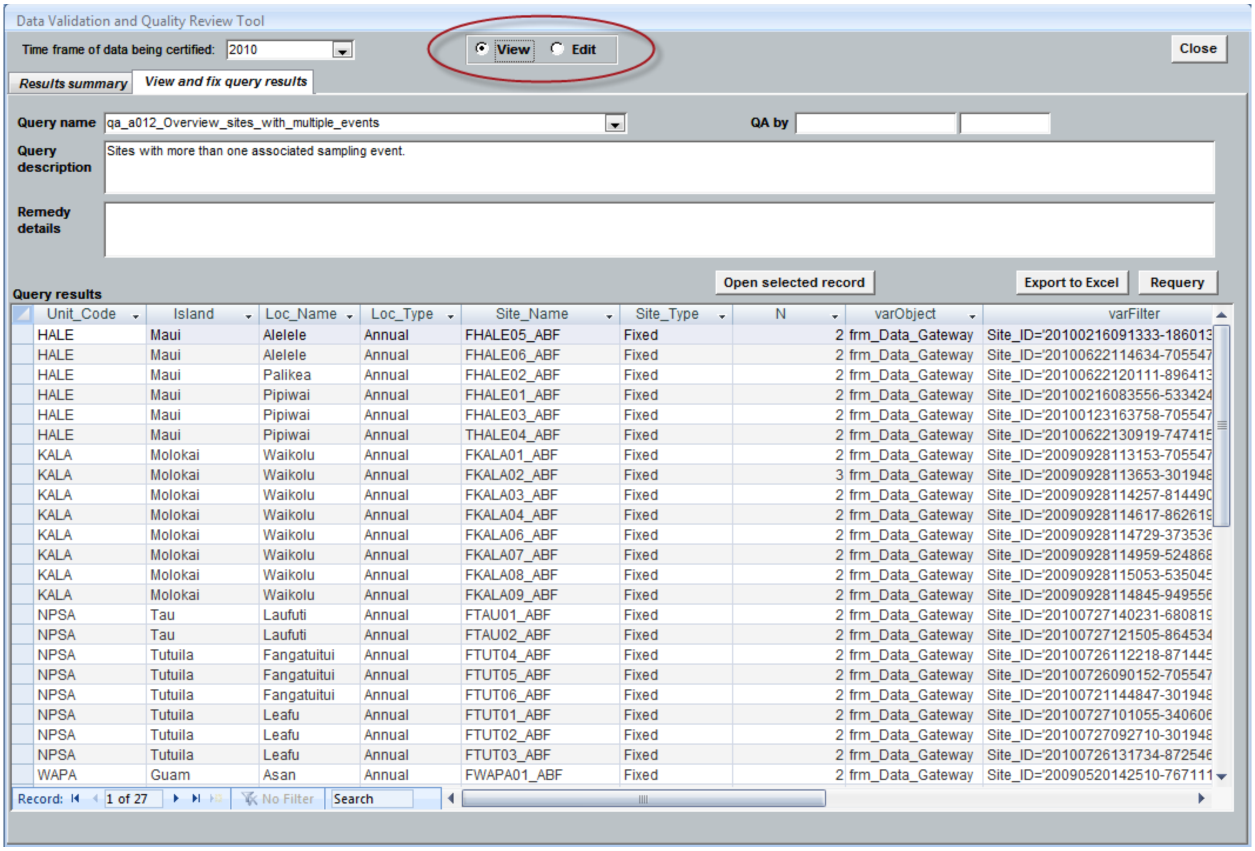
* Double-click on the label to change sort order. Click on a query name to open. | Query type: | Done: False | Refresh results | View summary report

Query name*	Type*	Done*	N recs*	Last run time	Description
qa_a012_Overview_sites_with_multiple_events	warning		27	01/19/2011 10:23	Sites with more than one associated sampling event.
qa_a023_Overview_sampling_event_summary	information		76	01/19/2011 10:23	Number of sites visited at each park, grouped by island, stream name, and stream type.
qa_a033_Quality_assurance_status	information		105	01/19/2011 10:23	Quality assurance status (i.e., unverified, verified, or updated) of all sampling events in the data s
qa_a042_Unverified_events	warning		102	01/19/2011 10:23	List of unverified sampling events in the data set.
qa_a052_Uncertified_events	warning		105	01/19/2011 10:23	List of uncertified sampling events in the data set.
qa_b011_Locations_missing_critical_info	critical		105	01/19/2011 10:23	Missing park, island, stream name, stream type, site name or site type.
qa_b022_Locations_duplicate_sites	warning		105	01/19/2011 10:23	Duplicate records on park, island, stream name, stream type, site name, and site type.
qa_b031_Locations_without_coordinates	critical		32	01/19/2011 10:23	Sampled sites without coordinate records.
qa_b043_Locations_missing_sampling_events	information		32	01/19/2011 10:23	Unsampled sites.
qa_b051_Location_illogical_dates	critical		32	01/19/2011 10:23	Updated date prior to created date, or discontinued date prior to established date.
qa_c021_Events_duplicates_on_sites	critical		56	01/19/2011 10:23	Duplicate event records on site ID.

Data Validation and Quality Review Tool Form – Results Summary Tab

The first tab of the Data Validation and Quality Review Tool form is the Results summary. Each query is sorted by name, type, if it was checked (done), the number of records returned by the query (N recs), the most recent run time (Last run time), the description, the action taken, who fixed it (Remedy by), and the date it was fixed (Remedy date). There are also fields to filter by query type (critical, warning, or information), if a record has been checked (Done), as well as buttons for refreshing the results (which may need to be done periodically as changes in one part of the data structure may change the number of records returned by other queries) and viewing a summary report.

To view the results of an individual query, click on the query name. The View and fix query results tab will open. At the top of the form is a switch that allows users to put the form in either view mode (default) or edit mode. Switching to edit mode means that the remedy details can be entered in the appropriate field (Remedy details). The QA by field will be automatically filled in once the user types in the remedy details.



Data Validation and Quality Review Tool

Time frame of data being certified: 2010 | View | Edit | Close

Results summary | View and fix query results

Query name: qa_a012_Overview_sites_with_multiple_events | QA by:

Query description: Sites with more than one associated sampling event.

Remedy details:

Open selected record | Export to Excel | Requery

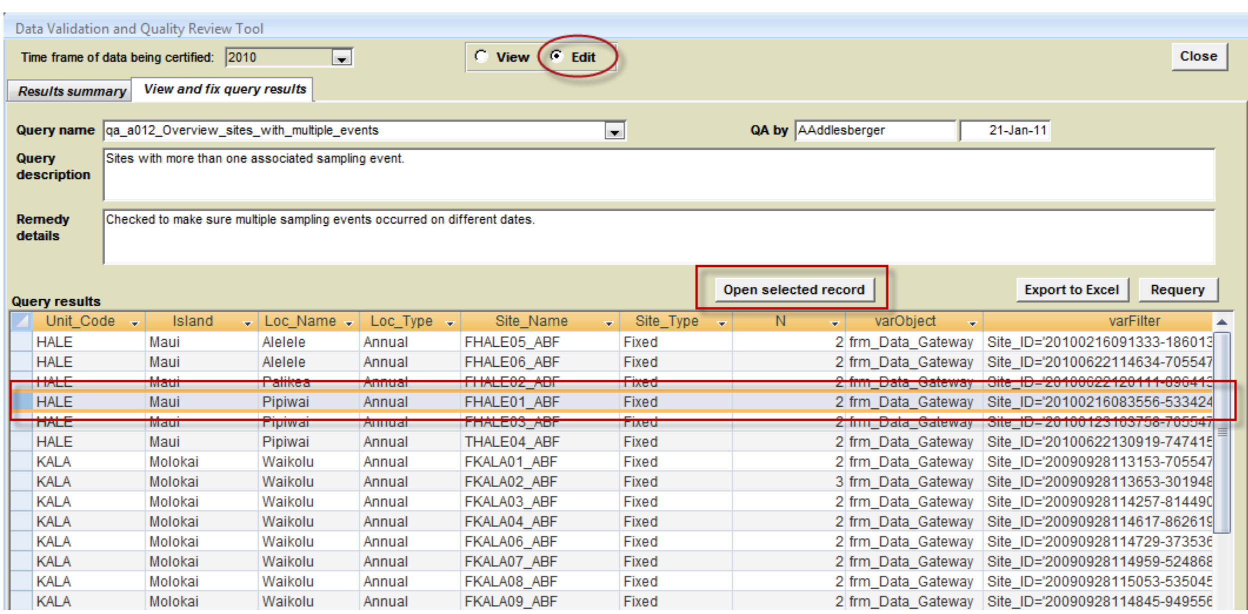
Query results

Unit_Code	Island	Loc_Name	Loc_Type	Site_Name	Site_Type	N	varObject	varFilter
HALE	Maui	Alelele	Annual	FHALE05_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100216091333-186013
HALE	Maui	Alelele	Annual	FHALE06_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100622114634-705547
HALE	Maui	Palikea	Annual	FHALE02_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100622120111-896413
HALE	Maui	Pipiwai	Annual	FHALE01_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100216083556-533424
HALE	Maui	Pipiwai	Annual	FHALE03_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100123163758-705547
HALE	Maui	Pipiwai	Annual	THALE04_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100622130919-747415
KALA	Molokai	Waikolu	Annual	FKALA01_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928113153-705547
KALA	Molokai	Waikolu	Annual	FKALA02_ABF	Fixed	3	frm_Data_Gateway	Site_ID='20090928113653-301948
KALA	Molokai	Waikolu	Annual	FKALA03_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114257-814490
KALA	Molokai	Waikolu	Annual	FKALA04_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114617-862619
KALA	Molokai	Waikolu	Annual	FKALA06_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114729-373536
KALA	Molokai	Waikolu	Annual	FKALA07_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114959-524868
KALA	Molokai	Waikolu	Annual	FKALA08_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928115053-535045
KALA	Molokai	Waikolu	Annual	FKALA09_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114845-949556
NPSA	Tau	Laufuti	Annual	FTAU01_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100727140231-680819
NPSA	Tau	Laufuti	Annual	FTAU02_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100727121505-864534
NPSA	Tutuila	Fangatuitui	Annual	FTUT04_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100726112218-871445
NPSA	Tutuila	Fangatuitui	Annual	FTUT05_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100726090152-705547
NPSA	Tutuila	Fangatuitui	Annual	FTUT06_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100721144847-301948
NPSA	Tutuila	Leafu	Annual	FTUT01_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100727101055-340606
NPSA	Tutuila	Leafu	Annual	FTUT02_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100727092710-301948
NPSA	Tutuila	Leafu	Annual	FTUT03_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100726131734-872546
WAPA	Guam	Asan	Annual	FWAPA01_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090520142510-767111

Record: 1 of 27 | No Filter | Search

Data Validation and Quality Review Tool Form – View and Fix Query Results Tab (View Mode)

Individual records should be viewed one at a time and errors or inconsistencies fixed as needed. To view an individual record, highlight the record and then click the Open selected record button.



Data Validation and Quality Review Tool

Time frame of data being certified: 2010 | View | Edit | Close

Results summary | View and fix query results

Query name: qa_a012_Overview_sites_with_multiple_events | QA by: AAddlesberger | 21-Jan-11

Query description: Sites with more than one associated sampling event.

Remedy details: Checked to make sure multiple sampling events occurred on different dates.

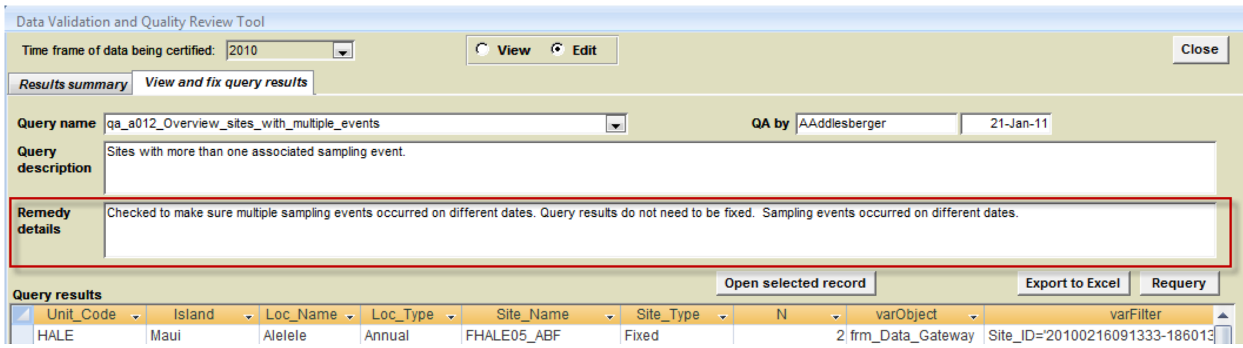
Open selected record | Export to Excel | Requery

Query results

Unit_Code	Island	Loc_Name	Loc_Type	Site_Name	Site_Type	N	varObject	varFilter
HALE	Maui	Alelele	Annual	FHALE05_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100216091333-186013
HALE	Maui	Alelele	Annual	FHALE06_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100622114634-705547
HALE	Maui	Palikea	Annual	FHALE02_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100622120111-896413
HALE	Maui	Pipiwai	Annual	FHALE01_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100216083556-533424
HALE	Maui	Pipiwai	Annual	FHALE03_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100123163758-705547
HALE	Maui	Pipiwai	Annual	THALE04_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20100622130919-747415
KALA	Molokai	Waikolu	Annual	FKALA01_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928113153-705547
KALA	Molokai	Waikolu	Annual	FKALA02_ABF	Fixed	3	frm_Data_Gateway	Site_ID='20090928113653-301948
KALA	Molokai	Waikolu	Annual	FKALA03_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114257-814490
KALA	Molokai	Waikolu	Annual	FKALA04_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114617-862619
KALA	Molokai	Waikolu	Annual	FKALA06_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114729-373536
KALA	Molokai	Waikolu	Annual	FKALA07_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114959-524868
KALA	Molokai	Waikolu	Annual	FKALA08_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928115053-535045
KALA	Molokai	Waikolu	Annual	FKALA09_ABF	Fixed	2	frm_Data_Gateway	Site_ID='20090928114845-949556

Data Validation and Quality Review Tool Form – View and Fix Query Results Tab (Edit Mode)

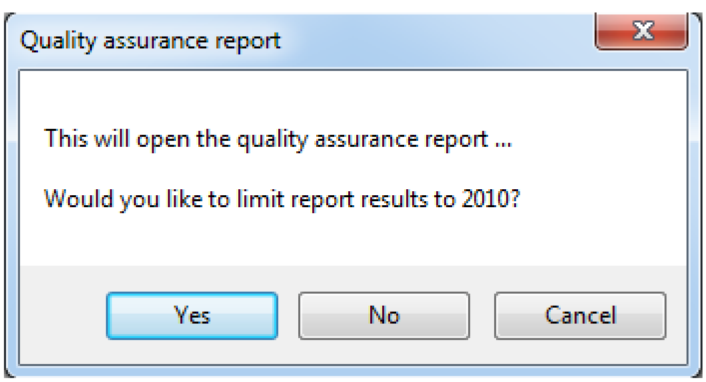
This will take you to the appropriate record(s) in the database and allow you to review the record and make modifications as needed. Once errors have been fixed, click the Requery button to update the Query results list. All changes should be documented in the Remedy details field. Keep in mind that not all errors and inconsistencies can or need to be fixed, but should still be documented in the Remedy details field.



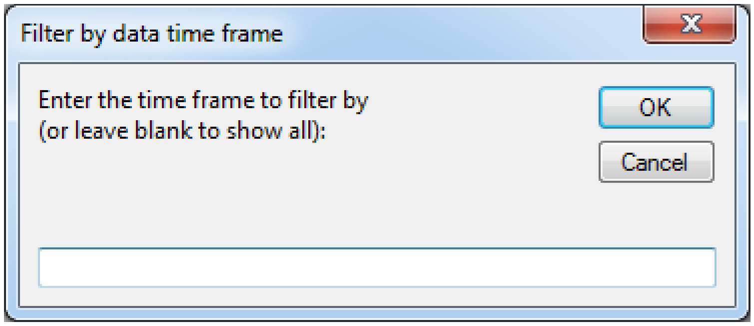
The list of query results can also be exported to an excel spreadsheet by clicking the Export to Excel button. To return to the results summary click the Results summary tab. Make sure to click the Done checkbox after a query has been reviewed and fixed for errors. Refreshing the results will move this query into the done category so you know that it has been checked (the list of queries that are done can be viewed by changing the Done filter to True at the top of the form).

The Data Validation and Quality Review Tool can also be used to generate summary reports. These reports include formatted information that lists queries by name, type, number of records, description, and any remedy details that were typed in by the user. All queries that were run will be shown in this report regardless if errors were fixed or not.

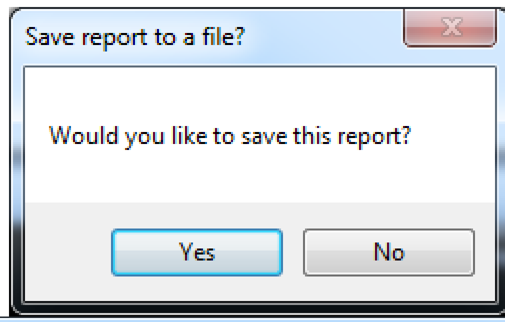
To generate a summary report click on the “View summary report” button on the Results summary tab. The Quality assurance report dialog box will open.

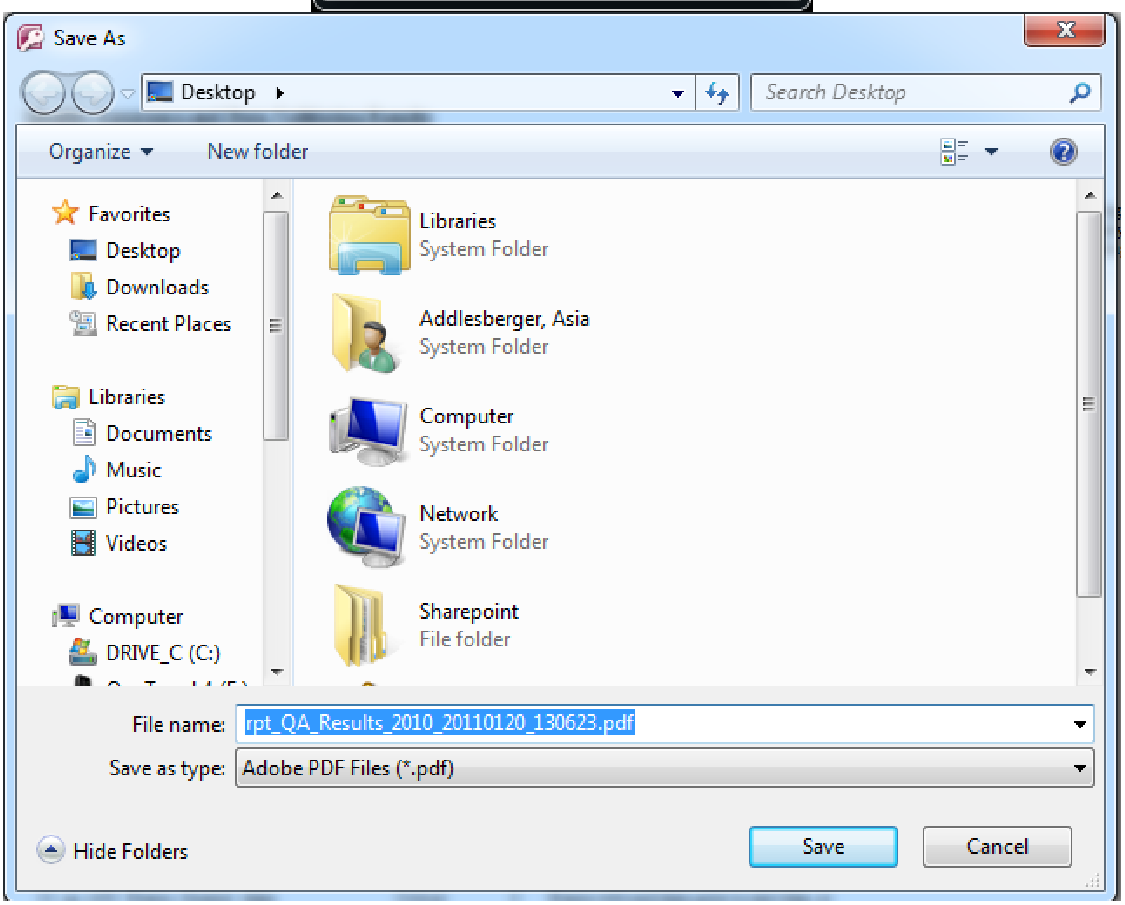


Click “Yes” if you would like to limit the report to the specified year. Click “No” to open the Filter by data time frame dialog box where you can enter a time frame or leave it blank to show all. Click OK when done.

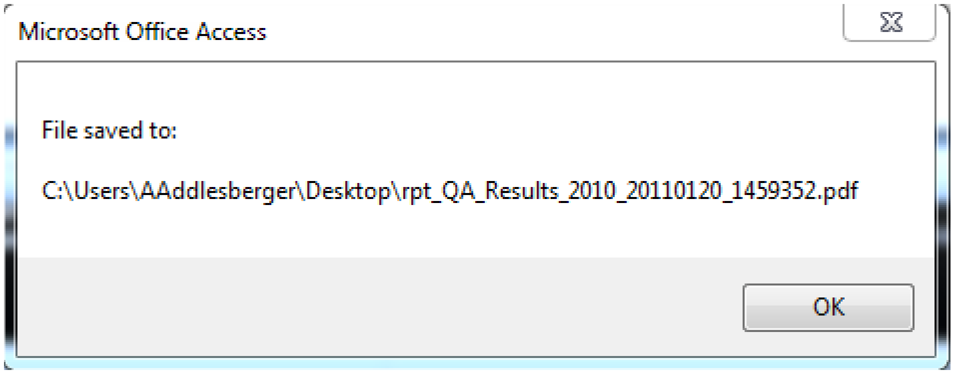


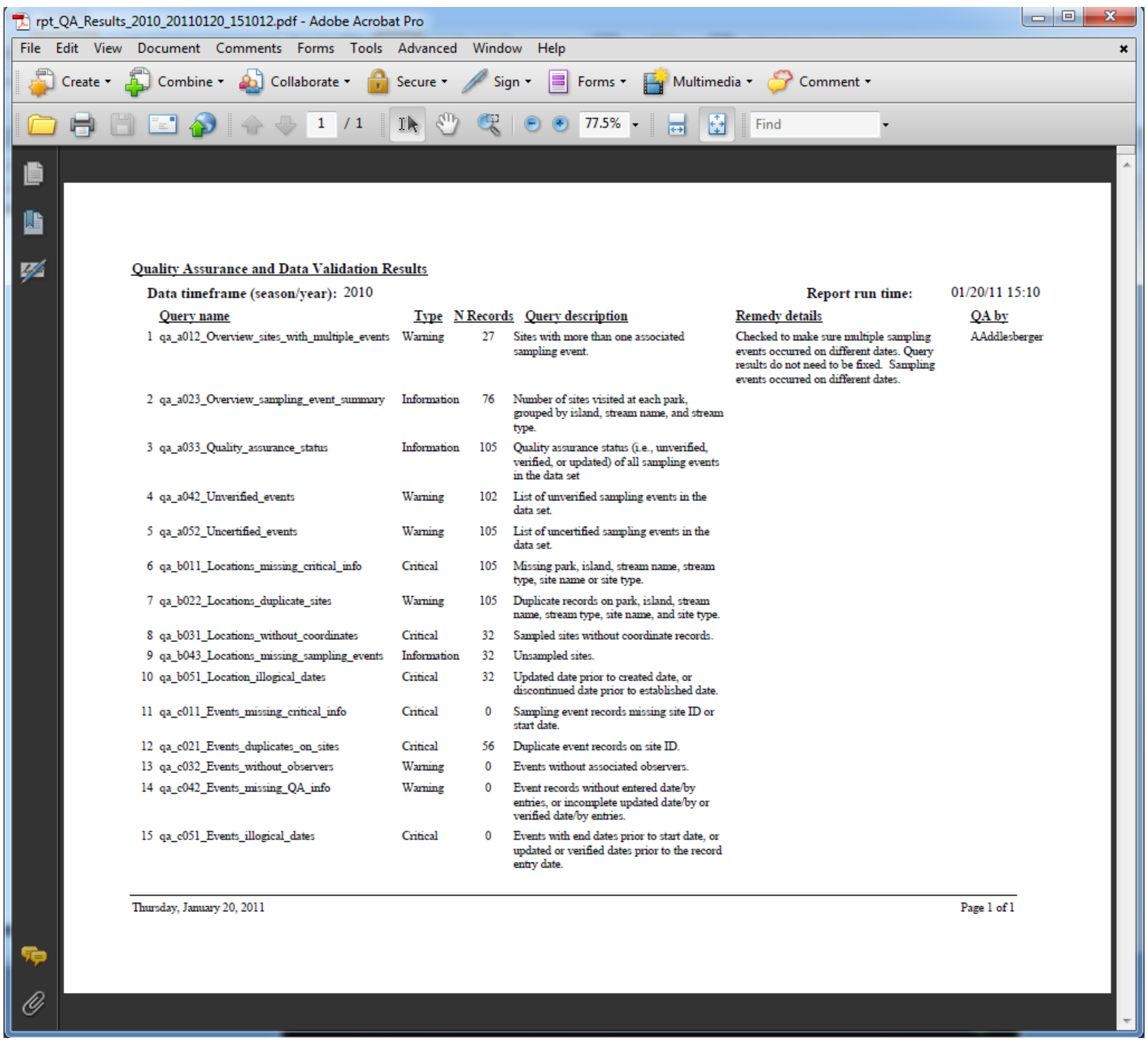
Once a time frame is chosen, you will have the option to save the report. Clicking “Yes” will allow you to choose a location and save the file as a .pdf. Clicking “No” will not save the file, but still allow you to view it in the database.





If you have chosen to save the summary report as a .pdf, a dialog box will open to confirm that the file has been saved. Adobe will also automatically open the file in a new window.





Quality Assurance and Data Validation Results

Data timeframe (season/year): 2010 Report run time: 01/20/11 15:10

	Query name	Type	N Records	Query description	Remedy details	QA by
1	qa_a012_Overview_sites_with_multiple_events	Warning	27	Sites with more than one associated sampling event.	Checked to make sure multiple sampling events occurred on different dates. Query results do not need to be fixed. Sampling events occurred on different dates.	AAddlesberger
2	qa_a023_Overview_sampling_event_summary	Information	76	Number of sites visited at each park, grouped by island, stream name, and stream type.		
3	qa_a033_Quality_assurance_status	Information	105	Quality assurance status (i.e., unverified, verified, or updated) of all sampling events in the data set		
4	qa_a042_Unverified_events	Warning	102	List of unverified sampling events in the data set.		
5	qa_a052_Uncertified_events	Warning	105	List of uncertified sampling events in the data set.		
6	qa_b011_Locations_missing_critical_info	Critical	105	Missing park, island, stream name, stream type, site name or site type.		
7	qa_b022_Locations_duplicate_sites	Warning	105	Duplicate records on park, island, stream name, stream type, site name, and site type.		
8	qa_b031_Locations_without_coordinates	Critical	32	Sampled sites without coordinate records.		
9	qa_b043_Locations_missing_sampling_events	Information	32	Unsampled sites.		
10	qa_b051_Location_illogical_dates	Critical	32	Updated date prior to created date, or discontinued date prior to established date.		
11	qa_c011_Events_missing_critical_info	Critical	0	Sampling event records missing site ID or start date.		
12	qa_c021_Events_duplicates_on_sites	Critical	56	Duplicate event records on site ID.		
13	qa_c032_Events_without_observers	Warning	0	Events without associated observers.		
14	qa_c042_Events_missing_QA_info	Warning	0	Event records without entered date/by entries, or incomplete updated date/by or verified date/by entries.		
15	qa_c051_Events_illogical_dates	Critical	0	Events with end dates prior to start date, or updated or verified dates prior to the record entry date.		

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When you are done working with the Data Validation and Quality Review Tool click the Close button to return to the main menu.

Data Summary Tool

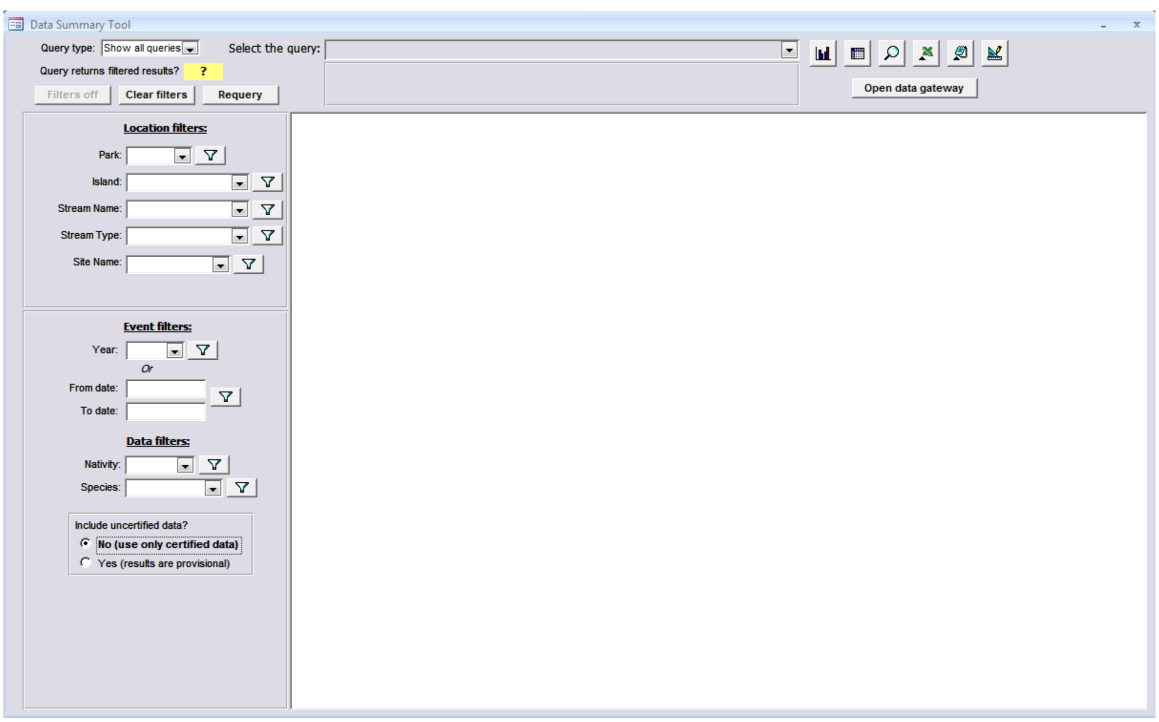
After the season's field data have been certified, data will be ready for summarization. The data summary tool contains queries that summarize and perform basic statistical calculations. These pre-built queries are developed based on what the project lead needs for their annual reports. The following table shows the prebuilt queries for the data summary tool. The queries are named and numbered hierarchically so that data types are grouped together.

Query_name	Returns records meeting the following criteria
qs_a011_Sampling_event_summary	Summary of freshwater animal communities, streams monitoring per park per year.
qs_a021_Sampling_event_sites	A list of monitoring sites. Can be filtered on park, island, stream name, or stream type.
qs_a031_Number_streams_sampled_per_park	The number of streams visited at each park.
qs_a041_Number_sites_sampled_per_stream	The number of sites visited at each stream.
qs_b011_Transect_discharge_per_stream	Total transect discharge by stream.
qs_b021_Transect_discharge_per_site	Total transect discharge by site.
qs_b031_Transect_depth_velocity_per_stream	Minimum and maximum depths and velocities of transects by stream.
qs_b041_Transect_depth_velocity_per_site	Minimum and maximum depths and velocities of transects by site.
qs_b051_Transect_habitat_type_per_park	A list of transect habitat types found at each park.
qs_b061_Transect_habitat_type_per_stream	A list of transect habitat types found in each stream.
qs_b071_Transect_habitat_type_per_site	A list of transect habitat types found at each site.
qs_b081_Transect_habitat_structure_per_park	A list of transect habitat structures found at each park.
qs_b091_Transect_habitat_structure_per_stream	A list of transect habitat structures found in each stream.
qs_b101_Transect_habitat_structure_per_site	A list of transect habitat structures found at each site.
qs_c011_Pebble_count_average	Average pebble size for each transect (excluding 998 and 998)
qs_c021_Pebble_count_998	Total count of records with a pebble size of 998
qs_c031_Pebble_count_999	Total count of records with a pebble size of 999
qs_d011_Mollusc_species_per_park	A list of mollusc species detected per park. Can be filtered by nativity and species name
qs_d021_Mollusc_species_count_per_park	Total number of molluscs (by species) found at each park. Can be filtered by nativity and species name.
qs_d031_Mollusc_species_count_per_stream	Total number of molluscs (by species) found in each stream. Can be filtered by nativity and species name
qs_d041_Mollusc_species_count_per_site	Total number of molluscs (by species) found at each site. Can be filtered by nativity and species name
qs_d051_Mollusc_nativity_count_per_site	Total number of native and non-native molluscs found at each site
qs_d061_Mollusc_habitat_type_per_park	A list of mollusc habitat types found at each park
qs_d071_Mollusc_habitat_type_per_stream	A list of mollusc habitat types found in each stream
qs_d081_Mollusc_habitat_type_per_site	A list of mollusc habitat types found at each site
qs_d091_Mollusc_habitat_structure_per_park	A list of mollusc habitat structures found at each park
qs_d101_Mollusc_habitat_structure_per_stream	A list of mollusc habitat structures found in each stream
qs_d111_Mollusc_habitat_structure_per_site	A list of mollusc habitat structures found at each site
qs_e011_Crustacean_species_per_park	A list of the crustacean species detected per park. Can be filtered by nativity and species name
qs_e021_Crustacean_species_count_per_park	Total number of crustaceans (by species) found at each park. Can be filtered by nativity and species name
qs_e031_Crustacean_species_count_per_stream	Total number of crustaceans (by species) found in each stream. Can be filtered by nativity and species name
qs_e041_Crustacean_species_count_per_site	Total number of crustaceans (by species) found at each site. Can be filtered by nativity and species name
qs_e051_Crustacean_nativity_count_per_site	Total number of native and non-native crustaceans found at each site
qs_e061_Crustacean_habitat_type_per_park	A list of crustacean habitat types found at each park

Query_name	Returns records meeting the following criteria
qs_e071_Crustacean_habitat_type_per_stream	A list of crustacean habitat types found in each stream
qs_e081_Crustacean_habitat_type_per_site	A list of crustacean habitat types found at each site
qs_e091_Crustacean_habitat_structure_per_park	A list of crustacean habitat structures found at each park
qs_e101_Crustacean_habitat_structure_per_stream	A list of crustacean habitat structures found in each stream
qs_e111_Crustacean_habitat_structure_per_site	A list of crustacean habitat structures found at each site
qs_f011_Fish_species_per_park	A list of the fish species detected per park. Can be filtered by nativity and species name
qs_f021_Fish_species_count_per_park	Total number of fish (by species) found at each park. Can be filtered by nativity and species name
qs_f031_Fish_species_count_per_stream	Total number of fish (by species) found in each stream. Can be filtered by nativity and species name
qs_f041_Fish_species_count_per_site	Total number of fish (by species) found at each site. Can be filtered by nativity and species name
qs_f051_Fish_nativity_count_per_site	Total number of native and non-native fish found at each site
qs_f061_Fish_species_count_per_quadrat	Total number of fish (by species) found at each quadrat. Can be filtered by nativity and species name
qs_f071_Fish_habitat_type_per_park	A list of fish habitat types found at each park
qs_f081_Fish_habitat_type_per_stream	A list of fish habitat types found in each stream
qs_f091_Fish_habitat_type_per_site	A list of fish habitat types found at each site
qs_f101_Fish_habitat_structure_per_park	A list of fish habitat structures found at each park
qs_f111_Fish_habitat_structure_per_stream	A list of fish habitat structures found in each stream
qs_f121_Fish_habitat_structure_per_site	A list of fish habitat structures found at each site

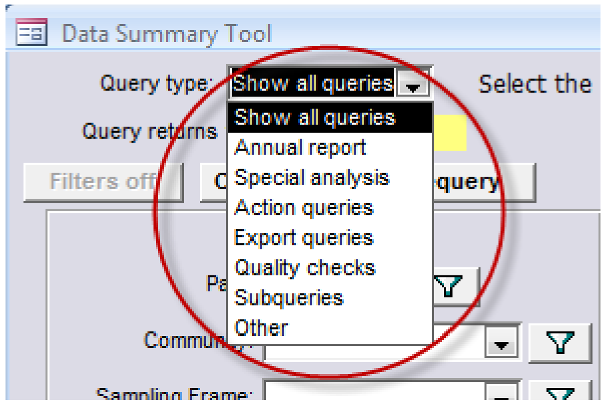
Data Summary Tool Form

To access the Data Summary Tool, click on the "Data Summary Tool" button on the switchboard. The Data Summary Tool form will open (see below).



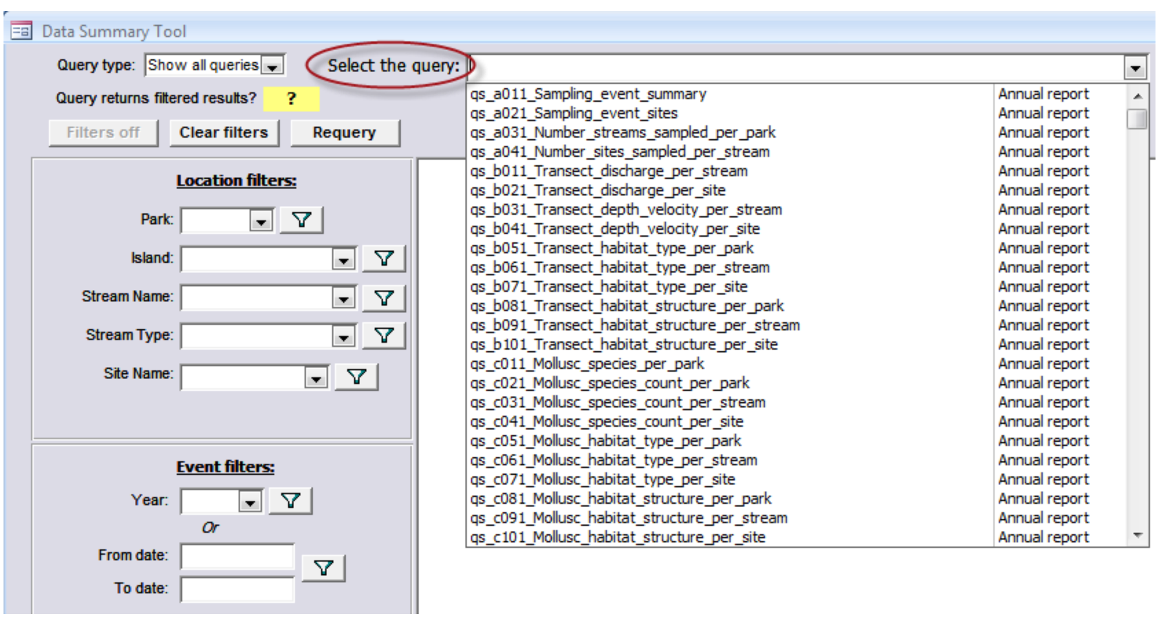
Data Summary Tool Form

The field "Query Type" in the top left hand corner contains a drop down list of the available query types (see below). Choosing the query type will filter the list of available queries displayed in the "Select the query" field. Some query types may not have any corresponding queries. If this is the case, there will be no queries listed in the "Select the query" field.

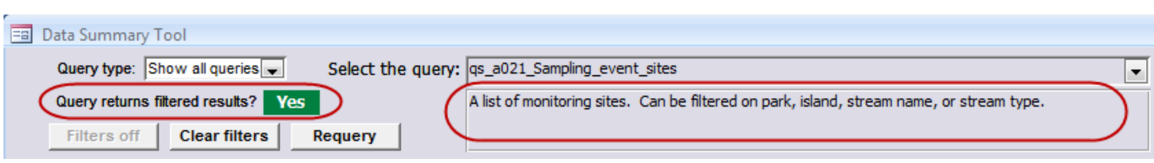


Query Types

To choose a query and view the results, choose from the list of available queries in the "Select the query" drop down list. Once a query is chosen, the description of the query will be displayed under the query name (see below). If the query returns filtered results, the box next to "Query returns filtered results?" will display "Yes".



Select a Query



Query Description

Many queries have the functionality to be queried. The available filters for the query chosen are listed in the query description. The available queries for the Stream Monitoring Database are:

Location Filters:

- Park
- Island – Maui, Molokai, Tau, Tutuila, or Guam. Field will be populated based on the Park chosen.
- Stream Type – Annual or Perennial.
- Stream Name –The stream name. Field will be populated based on the Park, Island, and Stream Type chosen.
- Site Type - Fixed or Temporary
- Site Name– The site name. Will be populated based on the Park, Island, Stream Type, Stream Name, and Site Type chosen.

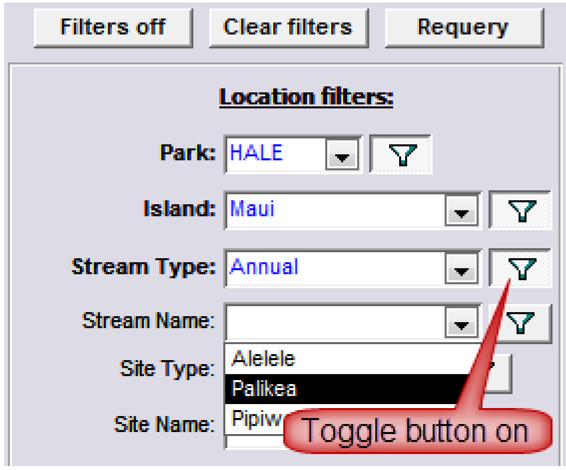
Event Filters:

- Year – all data for the year chosen
- From date and To date – all data for the time frame chosen

Data Filters:

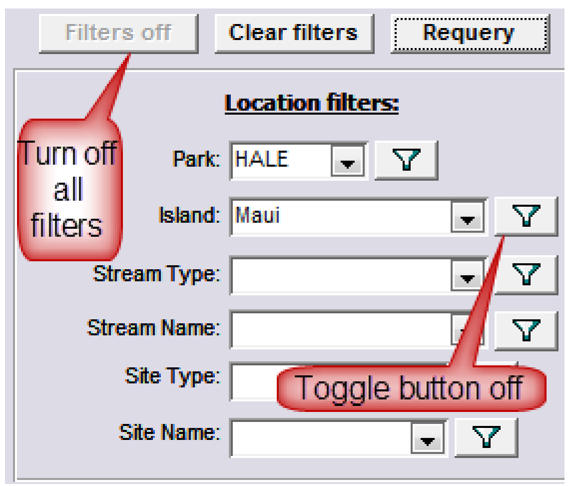
- Nativity – Native, Non-native, or Unknown
- Species – can filter on any species that is in the species look up table

To use a filter, chose a value from the drop down menu. For Location filters, filters must be chosen in order, i.e. Park, then Island, Stream Type, Stream Name, etc., as one filter's drop down list values are based on the filter value chosen above it. Once a filtered value is chosen, it is automatically turned on. This is shown by the filter value being displayed in blue, the filter label font becoming bold, and the toggle button to the right of the filter being turned on, which is displayed as being sunken (see below). Results in the subform will be requeried and the filtered results displayed.



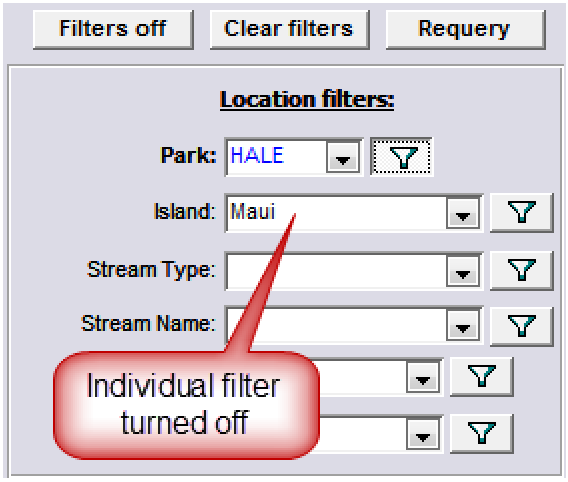
Filters On

There are several options for turning filters off. To leave the chosen values in the filter boxes, but turn off the filters, click the "Filters off" button. The filters will be turned off, the filter values will be displayed in black, the filter labels will no longer be bold, and the toggle buttons turned off, which is displayed as being raised (see below).



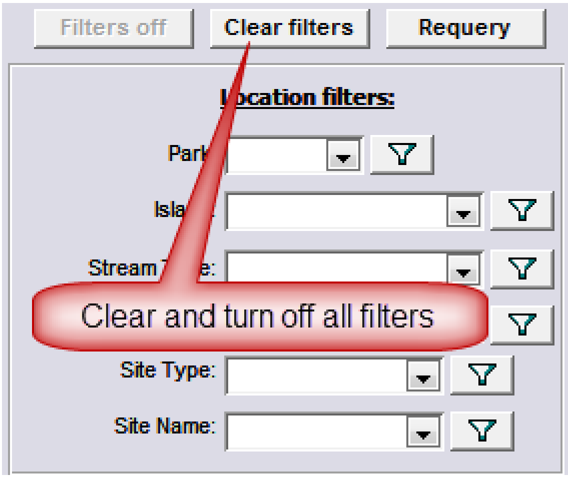
Filters Off

To turn off individual filters, click on the toggle button to the right of the filter. The filter will be turned off, the filter value will be displayed in black, the filter label will no longer be bold, and the toggle button turned off (see below). To turn the filter back on, click the toggle button again.



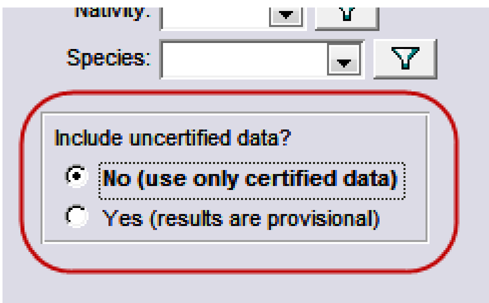
Individual Filter Turned Off

To turn off all the filters and clear the filters of their values, click on the "Clear filters" button. All filters will be cleared and the query subform will be requeried to display all results.



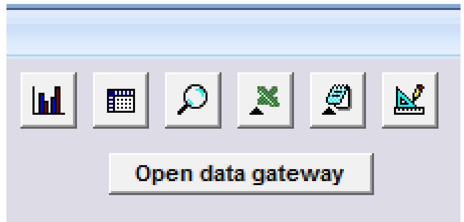
Clear All Filters

The last filter to turn on or off is the "Include uncertified data?" filter. The default is set to "No". This ensures that only certified data is displayed in the query results. To view all data, including uncertified data, click the "Yes" checkbox. If these queries are being used for annual data summaries or analysis, only certified data should be used.

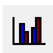


Certified Data Filter

There are options to view or export data in the top right corner of the Data Summary Tool form (see below). Clicking on an individual button will do the following actions.

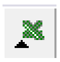


Data Viewing Options

 - View the selected query in chart view

 - View the selected query in pivot table view

 - Open the selected query in a new window

 - Export the selected query to Excel

 - Export the selected query to a text file

 - View the selected query in design view

Clicking the “Open data gateway” form will open the Data Gateway Form where data can be viewed and or edited.

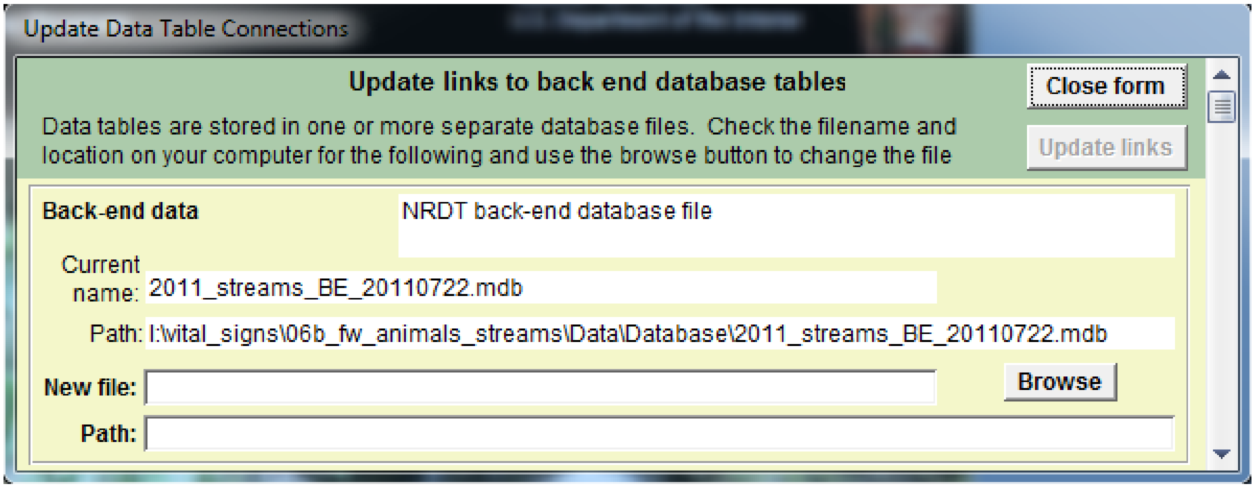
Back Up Data

Clicking the “Back up data” button will pop up a Yes/No box asking if you would like to make a backup copy of the data. If you select Yes, you will be prompted to select a folder in which to place the backup copy, which has a default name of *streams_BE_v1_yyyymmdd_hhmm.mdb*. You can rename the file if you would prefer a different name. Clicking the Save button creates the backup file and displays a success message.

Connect Data Tables

The application has a separate front-end (user interface) and back-end (data tables). In order for the application to work properly, the front-end file must be connected to the correct back-end file.

Clicking the “Connect data tables” button opens the Update Data Table Connections Form, which can be used to establish the link from the front-end to the back-end.

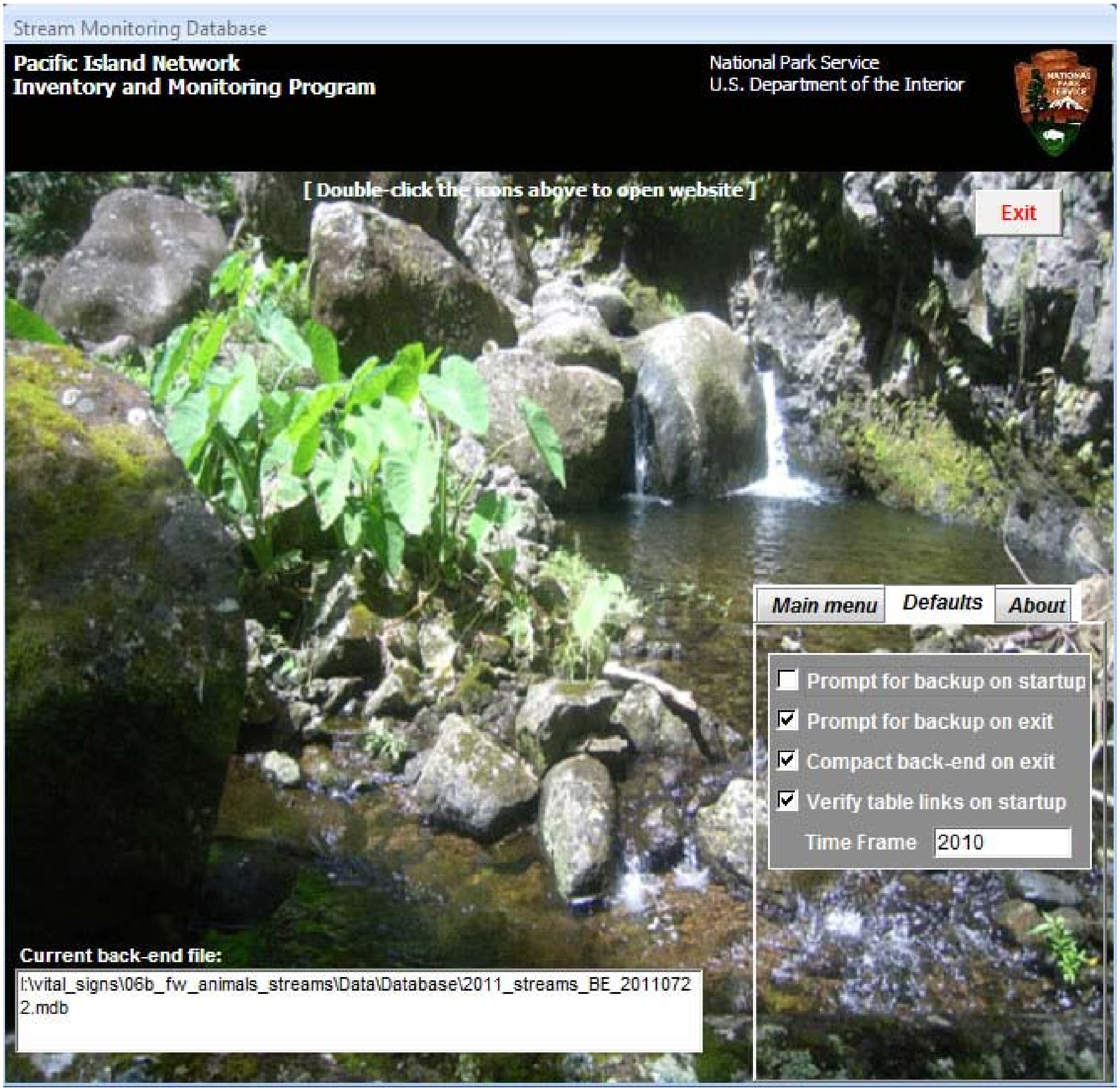


Update Data Table Connections Form

For each back-end file linked to the front-end, a record will be displayed on the Update Data Table Connections Form. The name, path, and file name of the current back-end file are displayed. To change the back-end file connection, click the "Browse" button, select a new back-end file, and click the "Open" button. You will be returned to the Update Data Table Connections Form and the New file and Path text boxes will be filled in. To make the new connection, click the "Update links" button. If the connection is made, a success message will be shown and you will be returned to the main menu.

Defaults

The Defaults menu provides check boxes for automatic backups on startup, backups on exit, data file compaction on backup, link verification on startup, and a field for time frame.



Defaults

Automatic Backups

The application can be set to automatically prompt for backups every time it is started and/or every time it is closed using the "Exit" button on the main form. Making backups before and after data entry sessions is a good habit to get into, in case of database corruption or data entry mistakes. Backups can also be run manually by clicking the "Back up data" button on the Main menu.

Compact Back-End on Exit

Compaction is a process whereby Microsoft Access optimizes the organization of the file, making it smaller and quicker to access data. If you check the option to Compact back-end on exit (recommended), the application will compact the data file that is linked to the front-end when the application is closed using the "Exit" button on the main form.

Verify Table Links on Startup

The application is structured with a front-end (user interface) and a back-end (data tables). In order for the application to work properly, the front-end must be linked to the tables in the back-end. If this check box is checked (recommended), the link to the back-end file(s) will be checked when the application is started.

Time Frame

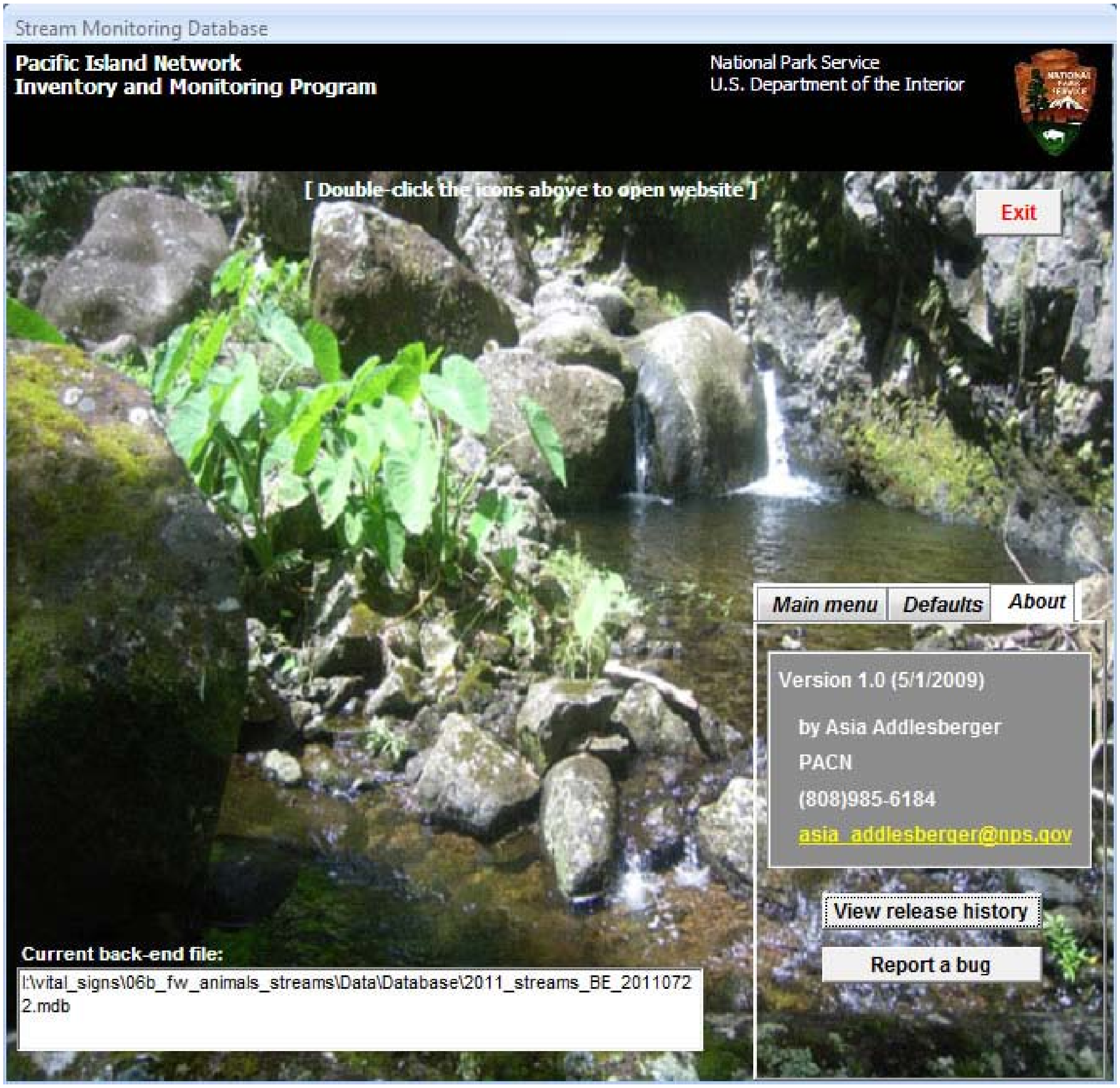
The time frame field will only need to be filled in once at the start of the field season. This field is necessary for the QA Queries to run properly and should be filled in with the date range of that field season (i.e., 2009-2010).

About

The About menu presents information about the application, including:

- Version number
- Application author
- Author organization
- Author phone
- Author email (click to email)

Buttons for viewing release history and reporting bugs are also provided on the About menu.

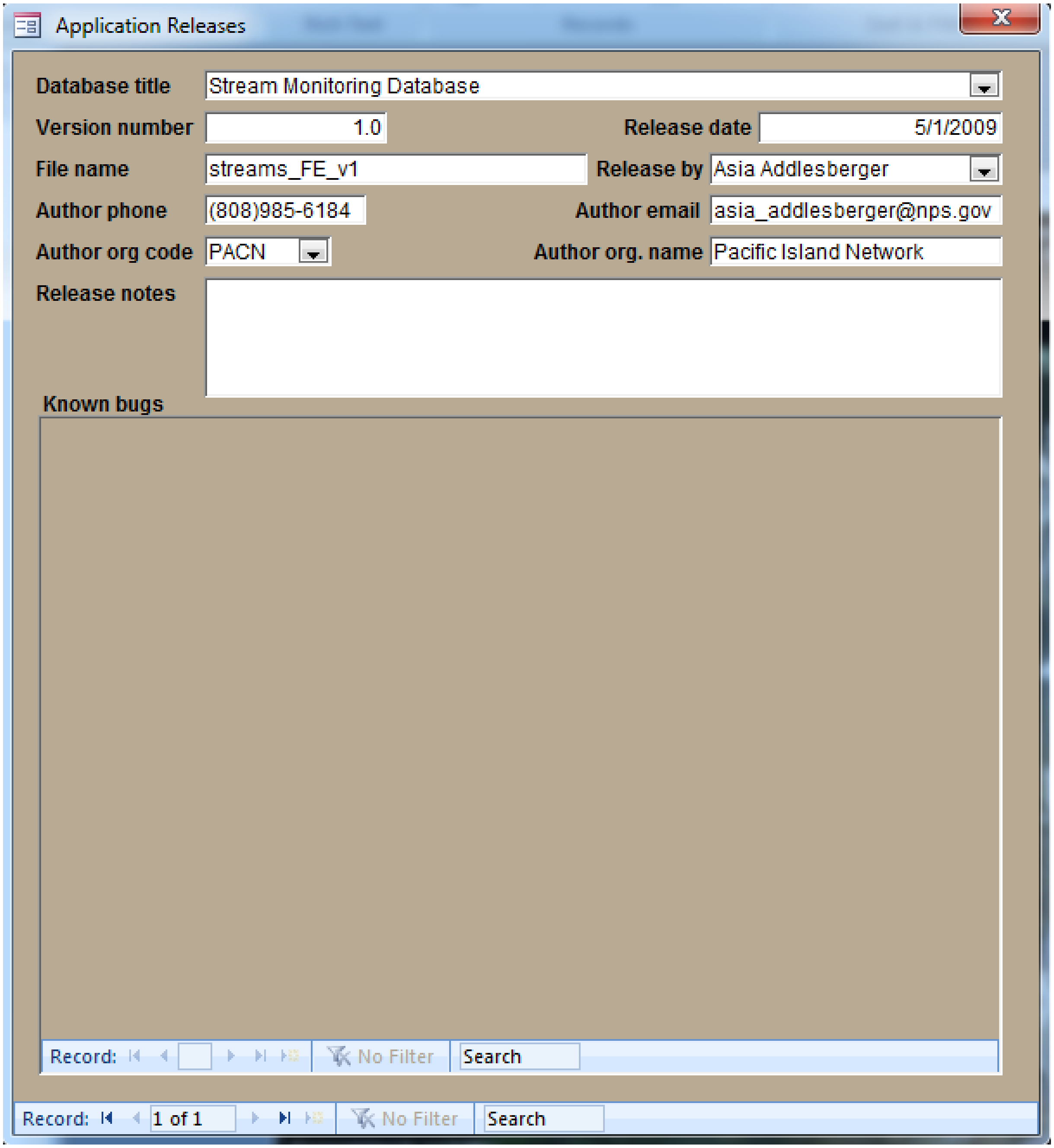


Defaults

Release History

Clicking the "View release history" button opens the Application Releases Form. This form provides information about all of the different versions of the application that have been released. It is filled in by the application developer before the application is distributed and is therefore read-only.

Included in the Application Releases Form are title, version, and release information about the application, information about the author of the application, and bug information.



Application Releases Form

Report a Bug

Clicking the "Report a bug" button will prompt the user to contact the application developer with the details of the bug. Developer contact information is located above the Report a bug button. The following information is useful when reporting a bug:

- application name
- application version

- name of the form/report you were on when the bug happened
- action, if any, you took right before the bug occurred
- screen capture of any error messages

Appendix 17: Revision history log

Master Version Table Revision History Log

Version key#	Date of change	Narrative	SOP #1	SOP #2	SOP #3	SOP #4	SOP #5	SOP #6	SOP #7	SOP #8	SOP #9	SOP #10

Version key#	Date of change	SOP #11	SOP #12	SOP #13	SOP #14	SOP #15	SOP #16	SOP #17	SOP #18	SOP #19	SOP #20	SOP #21	SOP #22

Version key#	Date of change	SOP #23	SOP #24	SOP #25	SOP #26	SOP #27	SOP #28	SOP #29	SOP #30	SOP #31	SOP #32	SOP #33	SOP #34

Version key#	Date of change	SOP #35

Standard Operating Procedures

The following section consists of 35 Standard Operating Procedures (SOPs) that provide comprehensive instructions for all aspects of conducting a monitoring program for stream macrofauna (fish, shrimp, and snails) and habitat characteristics of Pacific Island Network (PACN) National Parks. Included are SOPs on pre-season preparation; field surveys of fish, shrimp, and snails; habitat characterization; data management, data analysis and report preparation; and post-season activities. Appendices related to these SOPs include site maps, species identification guides, and data sheets for each monitoring activity.

Page

Standard Operating Procedures (continued)

Page

Standard Operating Procedures (continued)

Page

Standard Operation Procedure (SOP) #1:
Safety Protocol

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure explains the safety protocol for the operations using the Pacific Islands Stream Monitoring Protocol: Fish, Shrimp, Snails, and Habitat Characterization protocol and associated SOPs for the Pacific Island Network. This document outlines safety considerations for conducting any aspect of the protocol. All observers should be familiar with this SOP in order to identify and use the most current procedures and ensure optimum safety.

A master equipment list for the entire Freshwater Animal Communities: Stream Vital Sign Monitoring Protocol can be found in SOP #2: “Preparation for the Field Sampling.” The master equipment list should be updated simultaneously if any SOP requiring an equipment list is revised.

General Preparation and Review

Prior to conducting field work, observers are required to review this entire freshwater stream monitoring protocol, including all SOPs listed in this protocol. In particular, all participants should be thoroughly familiar with the NPS Occupational Safety and Health Policies, scuba and watercraft manuals, various environmental and chemical safety guidelines, procedures outlined in SOP #7: “Training Field Personnel,” as well as in SOP #2: “Preparation for the Field Sampling.”

The USGS National Field Manual (http://water.usgs.gov/owq/FieldManual/Chap9/content.html) is another recommended reference for safety procedures.

Federal employees, volunteers, partners, or cooperators are required to know and follow safety policies and requirements documented in Reference Manual 50 B Occupational Safety and Health Program (http://inside.nps.gov/waso/custommenu.cfm?lv=2&prg=46&id=5898). Boat operators should refer to Reference Manual 9 Watercraft Safety (http:// inside.nps.gov/waso/custommenu.cfm?lv=3&prg=704&id=2863) for safety guidelines. In addition, individual parks also have park specific safety procedures, and operational protocols.

Safety Policies, Regulations and Requirements

Ensure that all field personnel obtain First Aid and CPR training. Supervisory staff should ensure that all field staff are well trained in the safety guidelines and policies outlined below.

Weather

Sampling during inclement weather is of particular concern in the aquatic environments. Streams can swell drastically without warning and weather can change rapidly on the ocean, creating hazardous conditions in a relatively short time period. Prior to departure, it is the responsibility of all personnel to be aware of the appropriate local weather, tide, and current forecast for the day and to decide whether sampling should commence.

Sampling should be conducted during periods of little rain, mild wind, and small ocean swell. If thunder is heard or lightning seen while boating, sampling will be suspended and personnel should return to shore for at least 30 minutes. Do not stay on the water during a lightning storm. During intense rainfall events, visibility may drop and appropriate precautions should be taken to ensure that the boat does not ground. At any point during sampling, any personnel involved have the right and responsibility to abort a sampling trip if hazardous conditions develop.

Environmental Conditions

Individual parks have occupant emergency plans which cover safety procedures for medical emergencies, earthquakes, floods, fires, and tsunamis. Be familiar with the procedures and emergency contact numbers of your duty station park as well as other parks you may visit during field sampling activities.

Rough, steep, and slippery terrain will be encountered when conducting field work necessary for this protocol. Appropriate footwear should be worn to protect field personnel from injuries. Felt soled shoes should be worn in around streams. Sturdy hiking shoes should be worn while accessing field sites. Field conditions in the region are likely to expose crews to intense tropical sunlight, wind, and rain. Flash flooding should always be a concern when working near streams. High topographical relief in the region combined with the episodic nature of rainfall in the tropics leads to extreme flood events with little or no warning. Collecting freshwater stream data will require hiking over very rough and unstable terrain in hot and arid conditions. Appropriate precautions should be taken to protect field personnel from injuries as well as dehydration and exposure in these environments. Personnel should be prepared with adequate sun protection equipment (hats, sunscreen, etc) and plenty of drinking water. Access to certain field sites may require hiking long distances (up to 8 miles) over uneven terrain carrying heavy equipment (up to 50lbs). Camping in potentially inclement weather in backcountry sites may be required. Appropriate preparations and safety precautions should be taken.

Contaminated Water

Aquatic areas being sampled may be contaminated with pathogens or harmful chemicals although this situation is rare in the PACN. Consuming untreated or unfiltered freshwater may result in the contraction of bacterial diseases or parasites (e.g. *Leptospirosis*, *Giardia*.) Personnel should not work in water with open wounds to minimize exposure to parasites.

Animal Hazards and Disease Vectors

Any open cut has a high likelihood of becoming infected and all cuts should be carefully tended and monitored. It is the responsibility of all personnel to be familiar with the local hazardous flora and fauna and to understand the appropriate treatment methods.

Field Trip Preparations and Emergency Contacts

Table S.1.1 contains information a list of basic field survival equipment. No sampling activities will be conducted without all necessary safety equipment present and in proper working condition.

Table S.1.1 List of basic field survival equipment for the freshwater stream protocol.

Equipment (#/quantity)	Preparation & Maintenance
Water	Ensure that the proper quantities are available.
Water Filter	Ensure this equipment is available.
First Aid Kit	Keep stocked
Sunscreen	Ensure that the proper quantities are available.
Insect repellant	Ensure that the proper quantities are available.
Sunglasses (polarized)	Ensure that this equipment is available.
Headlamp	Ensure this equipment is available.
Headlamp batteries (usually AAA) (6)	Label and charge.
Appropriate raingear, clothing and footwear (including stream shoes)	Ensure this equipment is available.
Tent, sleeping bag (1/staff)	Ensure this equipment is available.
Personal items	Ensure this equipment is available.

Emergency Procedure

In the event of an emergency, the first action is ALWAYS to take care of the injured person and seek help. Once help is on the way and the situation is under control, the team leader or crew member should contact, or have someone else contact, the supervisor to inform them of the incident.

Standard Operation Procedure (SOP) #2:
Preparation for the Field Sampling

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes pre-field season procedures for monitoring stream fish, shrimp, and snails in PACN parks. The procedures described here are primarily the responsibility of the Field Lead (this role is filled by the Aquatic Biological Technician) who may be assisted in some tasks by the Project Lead (the PACN Aquatic Ecologist). Included in this SOP are a description of general preparations, field season scheduling considerations, and a list of necessary supplies and equipment for sampling. The procedures described here should begin no later than three months prior to a sampling trip.

Procedures

General Preparations and Review

1) Review the protocol (monitoring narrative and all SOPs). The Project Lead and the Field Lead should both be thoroughly familiar with the objectives of PACN stream protocol. They should also have a solid working knowledge of all field sampling methods and techniques.

2) Season specific plans. The Project Lead and Field Lead should review sampling goals, including scheduling and crew member responsibilities. A timeline of tasks and actual field sampling should be established (see Appendix 12 for details). The field lead should also review the previous season's field notes.

3) Permits. Obtaining all necessary permits is the responsibility of the Aquatic Biological Technician, who may be assisted by park staff or the Project Lead. Permits can be especially time-consuming to obtain and therefore, applications for these permits should be submitted well before the season begins. A minimum of 90 days is typically required. Scientific collecting permits need to be obtained from the appropriate state or territory agency, and each individual park where sampling will occur (Note: contact information regarding permits will be provided). Note that at least initially it may be necessary to fill out paperwork ahead of time but actually sign the collecting permits for Guam and American Samoa once you get there. For the National Park Service, there is a website http://science.nature.nps.gov/research Research Permit and Reporting System (RPRS) where permit applications are filed

4) Park contacts. At least two months prior to starting fieldwork, appropriate persons in the park should be contacted (Chief of Resource Management, Chief Ranger, other applicable staff that may be required to assist). Details are provided in Appendix #5: "Logistics".

5) Travel arrangements. Airline flights, boats (American Samoa), possible helicopter (to Waikolu), ground transportation, and lodging (hotel, park accommodations, or camping) should all be arranged well in advance. Details are provided in Appendix #5: "Logistics".

6) Supplies and equipment. All of the necessary supplies for the season should be located and inspected to ensure that they are in adequate condition. This includes, for example, field guides, data forms, GPS units, maps, preservative, and all sampling equipment. For additional details see the list of supplies and equipment (Table S.2.1) and associated data collection SOPs (SOPs #8-23). Supplies should be grouped together in containers according to sampling activity, and each container should have an attached checklist of all of the necessary supplies. Each field season a new set of data forms will need to be photocopied onto waterproof paper.

   All field equipment should be available and organized at least one month before fieldwork is scheduled to begin. All equipment should also be examined for functionality and completeness before fieldwork begins. For example, sampling traps should be clean and free of holes, and a sufficient supply of replacement batteries and pencils should be available. Wetsuits and waders should be inspected to ensure that they are clean and free of tears.

   It is very important that all gear (including personal items such as boots or tabis) be thoroughly cleaned to avoid inadvertently transporting introduced species to a new location. It is recommended that the field crew should have a different set of gear (including personal items such as boots) for each island group (Hawaii, Guam, and American Samoa). Details on preventing the transport on introduced species (aquatic hitchhikers) are provided in Appendix 5 (the logistics Appendix).

7) Location of sites. Prior to the field season, the Aquatic Biological Technician should check all GPS units to ensure that the location coordinates of sampling sites have been uploaded to each unit. Any unnecessary coordinates from the previous year should be deleted. A printout of all sampling location coordinates should accompany each unit as a backup reference for crew members. Laminated topographic maps with sampling locations marked on them should also accompany each GPS unit. Access points of difficult to reach areas should be marked on the maps and if possible, the coordinates of these points should be saved in the GPS units. Road or trail logs, in addition to site descriptions and contact information for landowners, park managers, or others should be maintained in a notebook.

Scheduling Fieldwork

1) Sampling schedule outline. A sampling timeframe has been established for each park (see Appendix#8: "Recommended Field Sampling Schedule"). This is coordinated with water quality monitoring, and has been selected to avoid the times of likely stream flooding.

2) Create a tentative schedule. A tentative schedule should be constructed for the entire field season, taking into account all logistical considerations. Ultimately, the sampling scheduling should provide a plan for the entire season, but flexibility for unforeseen circumstances should be built into the schedule.

Table S.2.1. Field supplies.

Personal Gear		
	Felt-soled boots	Backpack
	Wetsuit	Drinking water
	Hood	Food
	Dive gloves	Flashlight
	Rain jacket	Batteries
	Sun hat	Field notebook
Snorkeling survey/grid survey		
	Mask	Clipboards
	Snorkel	Pencils
	Fish quadrat wire	Flagging tape
	Snail quadrat wire	Waterproof pens
	Calipers	Identification keys
	SOPs	Fingerless gloves
	Data sheets	Ziploc bags for datasheets
	Random coordinates for quadrats	Transect lines
Electrofishing		
	Waders	Ruler
	Electricians' gloves	Measuring board
	Electrofisher	Calipers
	Charged batteries	Data sheets
	Buckets	Clipboards
	Sampling nets	Pencils
	Dip nets	Waterproof pens
	Flagging tape	Identification keys
	Tape measure	Ziploc bags for datasheets
	Aerators	Polarized sunglasses
	Batteries	
Trapping		
	Traps	Ruler
	Bait	Measuring board
	Rope and clips	Calipers
	Buckets	Data sheets
	Sampling nets	Clipboards
	Dip nets	Pencils
	Flagging tape	Waterproof pens
	Rugged gloves	Identification keys
		Ziploc bags for datasheets
Reach layout		
	Flagging tape	
	Waterproof pens	
	Tape measure	

Table S.2.1. Field supplies (continued).

Habitat measurements (rapid assessment)**		
	Flow meter**	Data sheets**
	Wading rod**	Clipboards**
	Yardstick	Pencils**
	Tape measure**	Flagging tape**
	Ruler**	Waterproof pens**
	Densiometer	Ziploc bags for datasheets**
General Gear		
	Site information folder	Laminated site map
	Camera	Permits
	Underwater camera	Equipment list
	Sample jars	Park/emergency contacts
	GPS	Field notebook
	small multi-tool	
Safety gear		
	First-aid kit	
	Sunscreen	
	Ear drops	
	Insect repellant	
	Cell phone	
	Radio/satellite phone	
	Drinking water	
	Spare snacks	
	Alcohol-based hand wash	
Other		
	Charger for electrofisher	
	Charger for camera batteries	
	Laptop	
	Waterproof paper data sheets	

Standard Operation Procedure (SOP) #3:
Locating Sampling Stations

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes the location of sampling stations. Logistics specific to each island are in Appendix #5: "Logistics." Table S.3.1 lists the equipment needed to locate and document sampling sites.

Procedures

Directions to field sites in the National Park of American Samoa.

Tutuila Field Sites

Leafu stream is accessed by traveling the main road to Pago Pago and the road over the mountain to the village of Vatia. Note there are no official road names in American Samoa. Roads are distinguished by the villages they connect. Village chiefs and the mayor must be notified prior to arrival in the village. This should take place several days to preferably at least a week in advance. FTUT01 is accessed through a villager's backyard. Consult homeowners before sampling. It is helpful to have employees that speak Samoan assist in communication efforts. FTUT02 and FTUT03 are accessed by a trail that follows on the banks of the stream. Permission is needed from the mayor of the Vatia to access these sites. Again notification of the mayor in advance is required. Trail is marked with blue flagging tape.

Fagatutui Stream (FTUT04-FTUT06) is accessed by traveling the road from Pago Pago towards the village of Fagasa. Park at the Mount Alava trail head; proceed up trail two miles until specified GPS point. Local staff know how to access these sites. It is helpful to have local knowledge. Trail is a very steep slope down and marked with pink flagging tape though there may be other trails in the area that can cause confusion. There are many streams in the area that look quite similar. It is extremely important to have accurate GPS coordinates when accessing the stream via trail. This stream can also be accessed via boat on days with calm sea conditions. The boat can is launched from the Fagasa boat ramp and driven 3 bays over to Fagatuitui Bay. Fagatuitui Bay is a distinctive looking bay with two streams that pour into the Bay. The sampled stream is the one on the right coming in from the ocean. Depending on sea conditions, crew capabilities, and boat specifications it may be possible to get relatively close to shore. However, it will be necessary to swim some distance to shore with all sampling gear. A float for the equipment will be required.

Amalau stream is accessed via the road from Pago Pago towards Vatia to the village of Amalau. Visitors must ask local villagers for permission to sample in Amalau stream. Permission should be obtained the day of, as well as several days in advance so they know to expect you. Site FTUT07 is at the mouth of the stream near the village fales. The site is accessed through private land. Remember to obtain permission. FTUT08 is easily accessed by walking upstream crossing highway and following stream until specified GPS point is reached.

In all travels to sites on Tutuila where village access is required, it is vitally important to recognize that you are traversing private land. When specific dates and times are established for sampling, these need to be honored. Local villagers get extremely upset when expected intrusions do not happen as planned. Also, following local customs is required. While sampling in village areas, dress must necessarily be modest and no work is to be conducted in village areas on Sundays. Contact park staff for any questions regarding local customs.

Tau field sites

All fixed field sites (FTAU01-FTAU04) are accessed via the beach trail at the end of the 4WD road. The trail leads over a short sandy beach, a boulder beach, and a relatively smooth forested trail. The trail then splits to access lower Laufuti and middle/upper Laufuti. Allow 30 minutes to trail junction. The trail down to lower Laufuti (FTAU01-FTAU02) is a steep, slippery slope that ends at a rocky beach. The trail was improved and a ladder installed in 2010 to assist hikers. Follow the coast along sandy and boulder beaches until the mouth of Laufuti stream. This takes approximately 2 hours from the split due to the rough terrain and heavy gear. To access the middle and upper sections of Laufuti (FTAU03-FTAU04), the trail follows the ridgeline up a steep climb. This trail can be extremely overgrown and may take extra time to cut through the vegetation with machetes. It is helpful to ask NPSA staff to cut the trail in advance. This saves hours of hacking through the jungle. Notify staff of intended arrival at least 2 months prior to facilitate trail clearing. The trail is flagged with blue and pink flagging tape though they may not be entirely visible if overgrown. The trail climbs through mostly fern forest. Many large boulders, exposed roots, moss covered lava rocks, and thick vegetation present hazards. Pants, long sleeve shirts, and mosquito repellant are essential. VIP Tuiluiga Simolea and NPSA Marine Technician Bert Fuiava know all field sites and access routes.

Directions to field sites in War in the Pacific National Historical Park

All field sites are located on Asan stream in the Asan Unit of War in the Pacific National Park. From the Airport or Tumon take highway 10A to Marine Corps Drive (Guam Route 1). Turn left and go approximately 6 miles. Turn left onto Jose Leon Guerrero Street. Park on street near bridge over Asan stream. Access the lower sites by heading upstream in the river. The first fixed site is approximately 70 meters upstream from the parking location, just immediately past the overhanging vegetation on the stream. Heading upstream, there is a trail on the left stream bank (right side when facing upstream) just past the second banana plantation where there are several limestone rocks in the bend of the stream. This trail can be used to facilitate quicker access to central river sites up to the dam. All sites can be accessed by hiking upstream in the stream; however, this is recommended only for sites downstream of FWAPA02 (lower sites).

Middle stream sites can be accessed by turning left onto Guam Route 6 from Marine Corps Drive toward the Asan Unit Overlook. Turn left onto Mama Sandy Road toward a residential area. Turn onto the small dirt road labeled J Street. Follow this road over the hill and then take the first dirt road to the right (it is unmarked as of January 2011). Follow this dirt road downhill until you reach the lowest cleared lot (the road will turn left and then start heading uphill again). Park in this cleared lot. At the entrance to the cleared lot, you will find an overgrown access road. Follow this road along the ridge until it turns to the left. Don't turn left (This is an extremely important direction note). Continue hiking over the ridge in front of you (the main ridge). All middle stream sites can be accessed from points along the main ridge. If luck is on your side, you will find a hash/pig trail that runs along the top of the main ridge. Follow this trail along the main ridge and use your GPS to access all sites in the middle portion of the stream. The uppermost middle site, FWAPA06, can be accessed by crossing this main ridge from the access road and continuing to head down the side ridge to the stream. You will enter the stream about 100 meters downstream of the site (this is not the current preferred route as it is presently overgrown with sword-grass, but it is an access route, and the frequent fires may change the vegetation making it an excellent access point in the future). As you access the middle trail sites, remember to keep the main valley to your right. There are several side ridges, which, if taken, will lead you into sword-grass fields and wasp lairs, which are better avoided. All sites in the middle stream can be access by heading upstream from the previous location.

Upper sites can be accessed by turning left onto Guam Route 6 from Marine Corps Drive toward the Asan Unit Overlook. Then turn left onto Mama Sandy Road toward a residential area. Turn onto the small dirt road labeled J Street and park. Walk through the lower cleared lots to the furthermost corner of the second cleared lot. There is a short, 15 minute trail down to the stream. This trail goes directly to the uppermost fixed site on Asan stream, FWAPA16.

Directions to field sites in Haleakala National Park

All field sites are located in the Kipahulu area of Haleakala National Park. From OGG follow the Hana Hwy/HI-360 (Hana way or north route) to Kipahulu or follow Haleakala Hwy/HI-37 to Piilani Hwy/HI-31 (south route) to Kipahulu. It takes approximately 3 hours each way from the airport to Kipahulu.

FHALE01 is located near the mouth of the stream and is accessed via the Seven Sacred Pools trail from the Kipahulu visitor's center. FHALE07 is accessed by taking the two mile long Pipiwai trail then following the rarely used Makahiku Falls trail (marked only by an old sign). Cross the bridge, and follow trail to the stream. Cross the stream to the right bank and follow the stream to appointed GPS point. FHALE02, FHALE08, and FHALE03 are located just off the Pipiwai trail. FHALE02 is at the lower USGS gauging station. FHALE08 is accessed by hiking upstream in Pipiwai Stream just after the confluence of Palikea and Pipiwai. FHALE03 is at the base of Waimoku falls just upstream of where the trail crosses the stream. FHALE09 is accessed by hiking in the stream up Palikea just after the confluence of Palikea and Pipiwai. Temporary sites on Palikea or Pipiwai streams can be accessed via the Pipiwai trail.

FHALE05, FHALE06, and all temporary sites on Alelele are accessed by following highway 31 south from Kipahulu to the Alelele bridge. Park in the pullout near the mouth of the stream. Follow the trail on the left bank of the stream to access all sites.

Directions to field sites in Kalaupapa National Historical Park

All field sites are located on Waikolu Stream. There are three access options. The first is to hike from Kalawao (20 minute drive from main Kalaupapa settlement) down to the boulder beach and across to Waikolu. The trail follows the coast alongside steep sea cliffs. Hardhats are required. The hike is not advised during periods of heavy rain as this can cause loose rocks to fall from cliffs. The hike is approximately 1.5 miles over a boulder beach with loose and slippery rocks. The hike takes 1-1 ½ hours depending on pack weight and weather conditions. The 2^{nd} option is boat from the settlement around the point to Waikolu. This requires extensive planning with local staff and calm sea conditions. The drive is approximately 45 minutes. Launching and loading the boat takes approximately 1 hour. The boat can be anchored in the bay for near shore gear unloading. Gear unloading takes approximately one hour. Camping is possible at the mouth of the stream with proper permission. The third option is to drive through the water diversion tunnel from topside. This allows easier access to sites above the pump house. Prior permission must be obtained through the Molokai Irrigation System part of the Department of Agriculture. A 4WD vehicle that meets the tunnels specifications must be obtained. Jeep Wranglers that meet these specifications are available for rent through Island Kine Rental Car (808-553-5242) located in Kaunakakai. Arrangements with workers must be made for directions to the tunnel and to borrow keys to access the tunnel. Contact Oscar Ignacio at 808-336-0587 for tunnel access. The drive takes approximately 2 ½ hours from Kaunakakai.

Once in Waikolu Valley, all sites below the tunnel can be accessed by hiking up the stream or from the trail. The trail goes from the mouth of the river to the pump house, and continues as a road to the tunnel. All sights above the tunnel must be accessed by taking the catwalk that goes from the tunnel to the diversion dam, and then hiking up stream. Sites near the tunnel and waterfalls can be accessed by taking the catwalk that crosses the valley to the collection pool at the base of the waterfalls, and then scrambling down to the stream below. The main trail along Waikolu stream starts on the left Bank of the lefter most branch of the stream (the extreme right of the valley facing upstream). Hike to the rocks that form the valley wall and begin walking upstream. This trail is unmarked in this location so some faith must be taken the trail is there. You will be touching the cliff as you hike the initial several meters of the trail. The trail then becomes somewhat more distinct and travels along both sides of the stream crossing in several places. GPS is useful in locating sites, but not always accurate or dependable as the signal gets degraded the further upstream you travel. Navigation by topographic maps is advisable, and at times required to locate the sites.

How to locate a site:

1) All sites are loaded into the GPS prior to a sampling event and the sampling station locations are printed on a map of the stream (See SOP 5: Downloading and Uploading data between Garmin GPS and ArcGIS).
2) Using GPS or a combination of GPS and available maps, the site is approached from the downstream direction (See SOP 4: Using Garmin Global Positioning System [GPS] Units).
3) When the GPS or GPS/map combination indicates you have reached the zero station mark, the lower end of the site is flagged.
4) The site will extend 30 m upstream of the indicated GPS point.

Table S.3.1. Equipment list for locating and documenting sampling site locations.

Equipment (#/quantity)	Preparation & Maintenance
GARMIN Global Positioning System (G.P.S.) unit (1)	Ensure that this equipment is available and set-up appropriately (according to SOP #4).
AA batteries (6)	Ensure this equipment is available. If rechargeable, ensure fully charged.
Waterproof case with desiccant and strap (1)	Ensure that this equipment is available. Replace desiccant pack biannually or if saturated.
Charts and grid layouts	Ensure that this equipment is available. Store in field binder.
Random number pair list	Create document and store in the field binder.
Compass (1)	Ensure that this equipment is available. Store in field binder.
Map of fixed and random sampling sites (2 copies)	Update prior to each trip with GIS specialist. Print in color to waterproof paper. Label sites. Store in field binder.
Fixed sampling site descriptions (with photo and compass heading)	Print to waterproof paper and store in field binder. Update If necessary prior to subsequent field sampling.
Park brochure and general map	Store in field binder.
ArcMap 10.0® software, Garmin Mapsource software	Check for software updates regularly

Standard Operation Procedure (SOP) #4:
Using Garmin Global Positioning System (GPS) Units

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure explains how to use an autonomous, non-differential Garmin (or similar unit) GPS receiver and GPS transfer software. This SOP is written specifically for Garmin GPSMap76CSx model, but it may be used for any other Garmin GPS models that can average a waypoint and collect track logs. The GPS transfer process uses DNR Garmin 5.4.1 and ArcGIS 9.3 software.

Pre-Field Preparation

Equipment

The following equipment should be taken into the field:

- GPS receiver.
- Map.
- Fresh AA batteries (at least 2).
- Compass with declination adjustment (if desired).
- Waypoint(s) preloaded (if necessary).
- Waypoint metadata form and pencil/pen.
- Notebook for recording description of waypoints.

Garmin GPS Preparation

1. Read and become familiar with Garmin GPS user manual, hardware, and software.

2. Load freshly charged batteries and have extra charged sets available. Put extra batteries in a water tight “dry bag” or a re-sealable plastic bag.

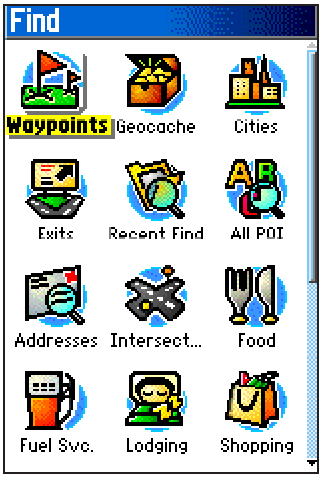
3. Download a fresh Almanac into your Garmin GPS if the unit has not been used for more than 1 week. Or if the GPS unit has been traveled a distance of 150 miles or more from the last location (i.e. travel between PACN islands). A fresh Almanac automatically sets the correct time/date and time zone for your GPS, as well as other local settings acquired from the satellites. To download an Almanac, turn on your Garmin GPS and stand in an open area (i.e. away from buildings, tree canopy, and obstructions) for about 20-30 minutes depends on cloud cover.

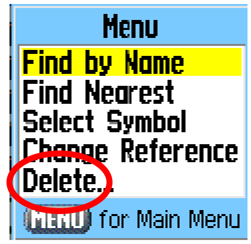
4. Get familiar with the Main Menu page and the Set Up page on your Garmin GPS.

5. Make sure your Garmin GPS interface is set correctly. From Main Menu page → Setup → Interface. Select *Garmin* for “Serial Data Format” field.

6. Make sure that WAAS is enabled. From Main Menu page → Setup → System. Set “WAAS” field to *Enabled*.

7. If necessary, delete old waypoints or tracks from your GPS memory (make sure data has been downloaded and saved on your computer).
   - To delete all waypoints, press FIND → Waypoints. Press ENTER, then press MENU. Select *Delete…*and press ENTER. Select *All Symbols* and press ENTER.
   - To delete all tracks, from Main Menu page → Tracks. Press ENTER, then press MENU. Select *Delete All Saved* and press ENTER. Select *Yes* and press ENTER.

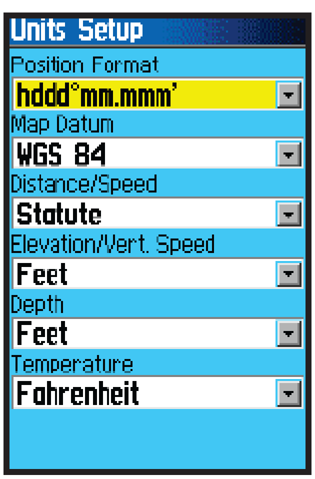




8. If necessary, upload GIS data (e.g. shapefiles) to the GPS unit using DNR Garmin software (see SOP #5: "Downloading and Uploading Data between Garmin GPS and ArcGIS" for instructions).

9. If you plan to GPS a line showing where you traverse (i.e. a track), then make sure to set up the Track Log. From Main Menu page → Tracks → Setup. Check the box *Wrap When Full* if you want Track Log records over oldest data with new data, otherwise leave the box unchecked. Set "Record Method" field to *Time*. Set "Interval" (i.e. logging rate for data collection) field to *00:00:05* (5 seconds is recommended for data collection while walking).

10. Set the coordinate system. From Main Menu page → Setup → Units. For the field "Position Format", select either *hddd.ddddd*, or *hdd mm.mmm*, or *hddd mm ss.s* if you want your waypoints collected in LAT/LONG. Otherwise select *UTM UPS*. Note: Standard unit for Distance, Elevation, and Depth is *Metric* or *Meters* for all PACN islands.



11. Set the Map Datum. From Main Menu page → Setup → Units. Set “Map Datum” field to either *NAD83* or *WGS84* depends on island location. Standard Map Datum settings for PACN islands are in Table 1 below.

Table S.4.1. Coordinate systems and datum for PACN islands.

Island	Datum	Coordinate system
Hawaii Island	NAD83	UTM zone_5N
Maui Island	NAD83	UTM zone_4N
Molokai Island	NAD83	UTM zone_4N
Oahu Island	NAD83	UTM zone_4N
Guam	WGS84	UTM zone_55N
Saipan	WGS84	UTM zone_55N
American Samoa (all islands)	WGS84	UTM zone_2S

12. If necessary, check North Reference setting. From Main Menu page → Setup → Heading. Set “North Reference” field to *True*.

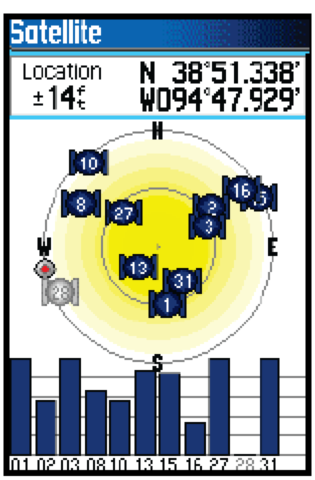
13. After using Garmin GPS in the field, make sure to put the unit in its carrying pack and store in a dry location.

GPS Field Procedures

Data Collection Preparation

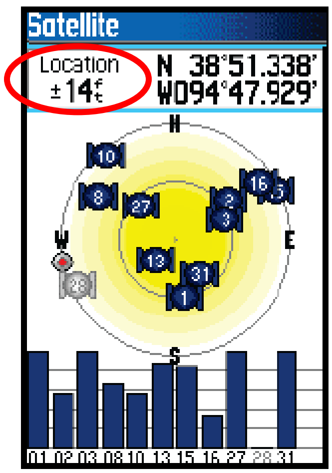
1. Turn on your Garmin GPS unit. Press PAGE button several times to access the Satellite page, then press MENU and select *Use with GPS On*, press ENTER.

2. Hold GPS unit in front of you. Keep it flat and leveled. Wait for the satellites to appear on the Satellites page. Note: A minimum of **4 satellites** is required to ensure data accuracy.



IMPORTANT NOTE: Garmin GPS will collect data regardless of how many satellites being detected or no matter what the GPS positioning quality is, therefore you must check the Satellites page frequently while collecting data. A good rule of thumb is ONLY collecting data when the 3D satellite fix mode signal is shown on the Status bar at the top of the screen of your GPS unit. Avoid collecting data when Garmin GPS is in 2D fix mode.

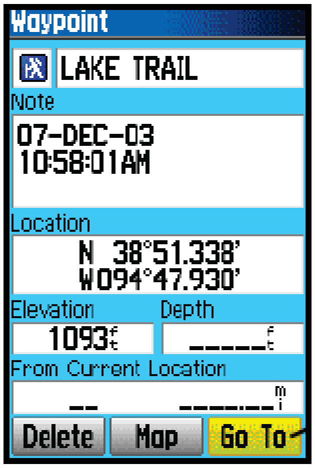
Also, check the Location accuracy error from time to time to ensure the GPS positioning quality when you collect data.



Navigating To Waypoints

1. Press FIND → Waypoints, press ENTER.

2. Use the Rocker key (move Up/Down or Left/Right) to enter the name of the waypoint or just select *OK*. Scroll down the list and select the waypoint that you want to navigate to, press ENTER. Select *Go To* at the bottom of the page and press ENTER.

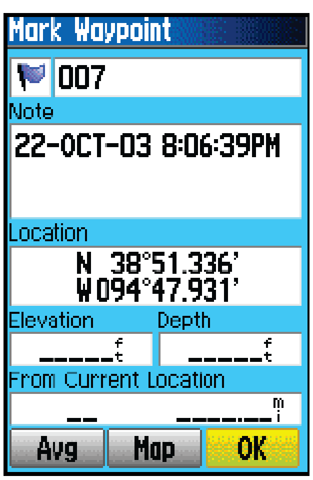


3. Map page should open automatically (if not, press PAGE button several times to access the Map page). Start walking and follow the compass direction on the Map page to navigate to the waypoint.

Collecting Waypoints

1. Stand still at the location where you want to GPS.

2. Press and hold ENTER/MARK button until the Mark Waypoint page appear.



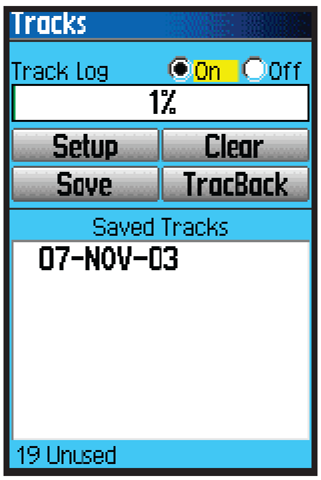
3. At the top of the Mark Waypoint page, enter a waypoint name, using the Rocker key. Tip: To save time in the field, write down any notes/comments about this waypoint into a notebook. You may enter this information later back at the office, after downloading the waypoints into ArcGIS.

4. Select OK at bottom of the page and press ENTER.

5. Go to your next location and repeat the above steps.

Collecting Tracks

1. Turn Track Log to ON. From Main Menu page → Tracks. Select *On* and press OK.
   Also, from Main Menu page → Tracks → Setup Track Log, make sure the box *Wrap When Full* is checked if you want Track Log records over oldest data with new data (otherwise leave the box unchecked).



2. Begin walking and Track Log will start collecting track points (at an interval of every 5 seconds as you walk).

3. Turn Track Log to OFF to stop collecting. From Main Menu page → Tracks. Select *Off* and press OK.

4. Tip: You may stop Track Log when nearing the beginning point of an area (polygon) you've walked. Track Log will automatically close the polygon even if a track is left open ended.

Other Data Collecting Tips

1. For more detail information on data collecting with Garmin GPS, check out the User's Guide at this link:
2. http://www8.garmin.com/manuals/GPSMAP76CSx_OwnersManual.pdf

Standard Operation Procedure (SOP) #5:
Downloading and uploading data between Garmin GPS and ArcGIS

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes how to download/upload GPS data using DNRGarmin, free software that is the Pacific Islands NPS standard for incorporating Garmin GPS data into GIS. This SOP is written specifically for Garmin GPSMap76CSx model, but it may be used for any other Garmin GPS models that can average a waypoint and collect track logs. The data transfer process uses DNR Garmin 5.4.1 and ArcGIS 9.3 software.

Installation of DNR Garmin Software

1. If you already have DNR Garmin 5.4.1 installed on your computer, go to next section “Connect Garmin GPS unit to Computer” below.
2. If a previous version of DNR Garmin exists on your computer, start from Step 3. If there is no previous DNR Garmin software on your computer, start from Step 5.
3. Uninstall any previous versions of DNR Garmin by using the Start → Control Panel → Add/Remove Programs function.
4. When uninstallation is done, perform a search on local drives for all files named “dnrgarmin”. If found, delete them. Note: Failure to completely remove any earlier versions can cause problem running the current DNRGarmin version.
5. Install DNRGarmin: If you have access to I&M server, go to M:\Software\GPS_Garmin\DNRGarmin5.4.1, then go to Step 6 to install the software.

   If you don’t have access to I&M server, you may download the free DNR Garmin 5.4.1 software from the Minnesota Department of Natural Resources at this link http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html and then go to Step 6 to install it.

6. Double click the dnrgarmin54setup.exe file.
7. Press "Next" at the Welcome Screen, then accept the License Agreement. Press "Next" to continue.
8. The program will be installed in a default location "c:/program files/dnrgarmin". Press "Next" to continue.
9. The program will install a desktop shortcut and a DNR Garmin folder will be added to the Start → All Programs menu. Press "Finish" and view the Readme file if desired, otherwise close Readme file.

Connect Garmin GPS Unit to Computer

1. Attach the Garmin Cable to either a COM1 serial port or a USB port (depends on what type of cable that comes with your Garmin GPS unit) in the back of your computer.
2. Attach the other end of the Garmin Cable to the back of the Garmin GPS.
3. Turn on the GPS by pressing and holding the red lantern button.
4. Press the Menu button and select the "Use With GPS Off".
5. Press Enter and the Garmin should be in Simulator Mode (GPS unit no longer is searching for satellites).
6. Press the Page button several times until you get to the Main Menu.
7. Make sure the "Serial Data Format" field is set to *Garmin*. From Main Menu page → Setup → Interface.
8. You're now ready to download or upload data between a Garmin GPS unit and your computer.

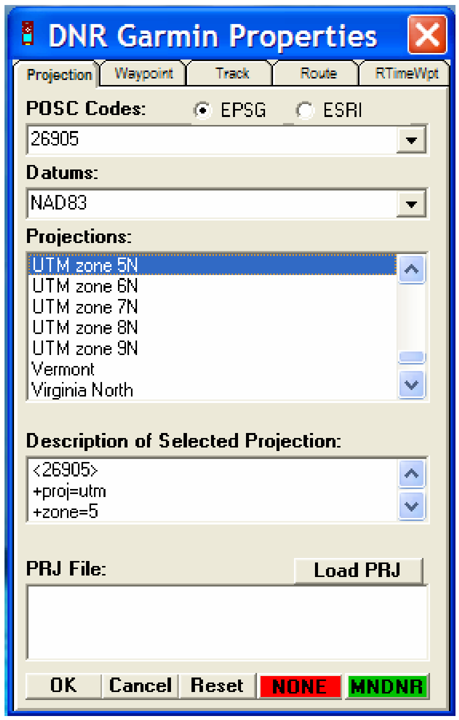
Download GPS Data into ArcGIS

GPS waypoints and tracks collected in the field can be downloaded directly into ArcGIS as shapefiles.

1. Open ArcMap.
2. Launch DNR Garmin from the desktop shortcut or loading from All Programs → DNR Garmin. You should see a screen announcing version 5.4.1 and MN-DNR Garmin window opens with the word "Connected" displayed at the bottom. **If you receive a connection error message or "Not Connected" displayed at the bottom of the DNRGarmin screen, go to section "Connection Troubleshooting Guide" at the end of this document for suggested steps to resolve connection problem.**
3. When DNR Garmin opens for the first time on a computer, you will be asked to accept or change the default projection of UTM -1983, Zone 15. Select NO to change the default projection.
4. The DNR Garmin Properties dialog box appears.
5. Set projection based on Table 1 below.

Table S.5.1. Projection settings for islands in PACN

Island	ESRI (or EPSG) POSC code	Datum	Projection
Hawaii Island	26905	NAD83	UTM zone_5N
Maui Island	26904	NAD83	UTM zone_4N
Molokai Island	26904	NAD83	UTM zone_4N
Oahu Island	26904	NAD83	UTM zone_4N
Guam	32655	WGS84	UTM zone_55N
Saipan	32655	WGS84	UTM zone_55N
American Samoa (all islands)	32702	WGS84	UTM zone_2S

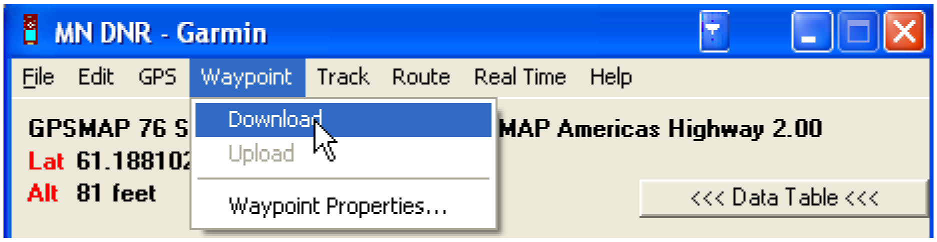


6. When Finished Press OK. **These projection settings MUST be checked EACH time you download GPS data** by selecting File → Set Projection.
7. In ArcMap, ensure that the Data Frame is set to the appropriate projection:

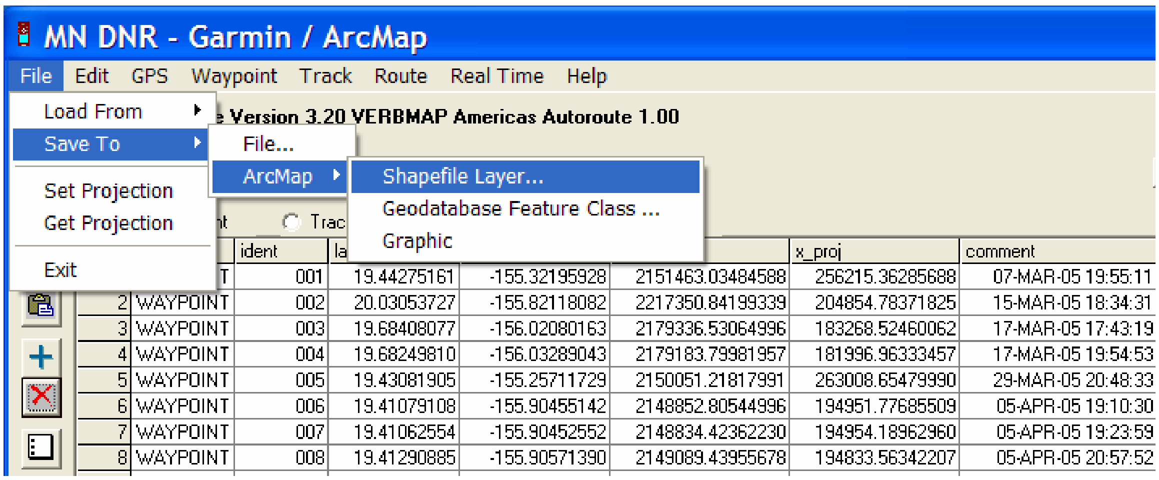
- Right click on Data Frame name, select Properties.

- In Data Frame Properties window, select Coordinate System tab. Read the information in Current Coordinate System box. It should have the same Datum and Projection as the GPS data you're about to download. If it is NOT the same or "No projection" is displayed, then go down to Select a Coordinate System box, click on Predefined folder and select the appropriate coordinate system (refer to Table 1 above). Download the waypoints (or tracks) into ArcGIS:

First, download waypoints into DNRGarmin by selecting Waypoint (or Track) → Download. The waypoints (or tracks) will be tabulated and it might take a while.



Next, you MUST save the waypoints (or tracks) as a GIS layer by selecting File → Save To → ArcMap → Shapefile Layer.



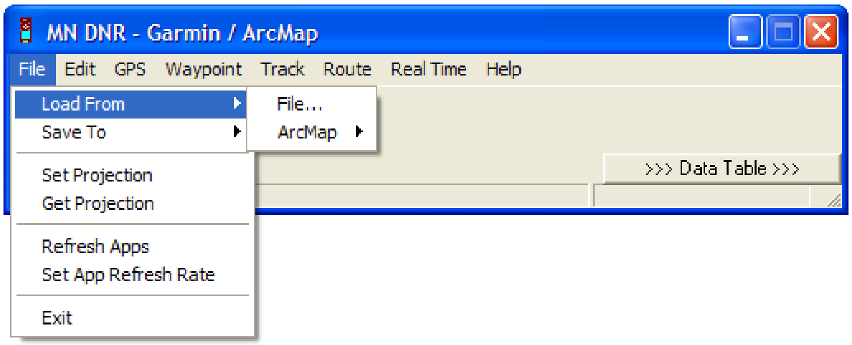
Select a location folder and type in a name for the shapefile.

Press the Save Button. The new shapefile will be automatically added into ArcMap.

Upload GIS Data into Garmin GPS

GIS data (point, line, polygon shapefiles) can be uploaded into the Garmin GPS unit to be used as background map features or locations to navigate to.

1. Connect GPS to computer (see section "Connect Garmin GPS unit to Computer" above).
2. Launch DNRGarmin.
3. Go to File→Set Projection to change the coordinate system if needed. It should match the coordinate system of the GIS data you want to upload.
4. Chose either of the 2 methods below to start uploading data.

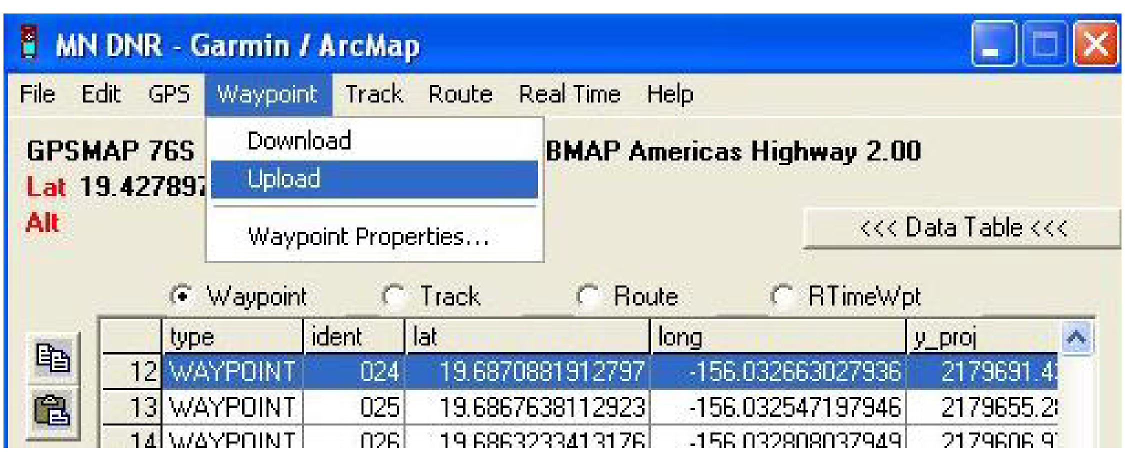


From ArcMap Method
This is an option if you already have an ArcMap project opened and you want to upload a layer from your map project into the Garmin GPS.

1. In ArcMap Table of Content, highlight the layer you want to upload.
2. In DNRGarmin, select File → Load From → ArcMap → Layer. Data will be transferred into DNRGarmin. Note: The data are NOT uploaded into your GPS yet, must perform step 3
3. From the Waypoint (or Track, Route) menu, select Upload and data will be uploaded into the GPS.

From DNRGarmin Method

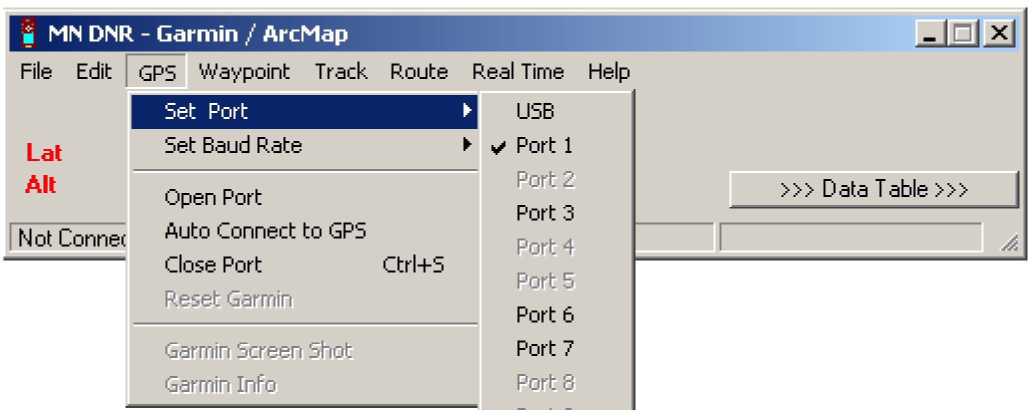
1. Go to File → Load From → File. Select *Shapefile* as Files of Type. Navigate to where the shapefile is located on your computer and select it. Press Open.
2. An Identify Fields dialog may open. Fill in the appropriate fields if necessary. Click OK. Data will be transferred into DNRGarmin. Note: The data are NOT uploaded into your GPS yet, must perform step 3.
3. From the (or Track, Route) menu, select Upload and data will be uploaded into the GPS.



Connection Troubleshooting Guide

Here are some steps to follow if you failed to make a connection between the GPS unit and your computer:

1. Ensure the GPS is in Garmin Interface Mode. On your Garmin GPS unit, from Main Menu page → Setup → Interface. Check to make sure the "Serial Data Format" field is set to *Garmin*.
2. Check all cable connections to ensure everything is secured tightly. In DNR Garmin, click GPS →Set Port. Make sure *Port 1* is checked if you attached the cable to COM1 serial port. Otherwise, *USB* should be checked if you attached to a USB port on your computer.
3. If your computer has two or more serial ports, make sure you are attached to COM1. If COM1 port is already taken up by another cable (printer, scanner, etc.), attach the Garmin cable to another available serial port, i.e. COM2, COM3. Then in DNR Garmin, go to GPS → Set Port and select Port2 or Port 3 accordingly.



4. If you are using a serial port cable, make sure it has 4 prongs on one end (where it attached to the back of the Garmin GPS unit) and a parallel port on the other end (attached to a parallel port on your computer).
5. If you are using a USB cable, **you may need to install a USB driver to make this connection work**. The driver is available on I&M server. Follow the steps below to install the USB driver on your computer (you must have administrative privileges to install):
   - Close all running programs.
   - Go to M:\Software\GPS_Garmin\USB Driver. Double click on USBDrivers_221.exe
   - Click Run button to start the installation process.
   - Click Next.
   - Select "I accept the terms in License Agreement", then click Next.
   - Select "No, Not at this time", then click Next.
   - Select "Install the software…(Recommended)", then click Next.
   - Click Finish.

- Restart your computer when installation is successfully done.
- Connect USB cable from Garmin GPS to your computer. Turn on GPS unit, check to make sure “Use with GPS off” is set and GPS is in Garmin Interface Mode (refer to section “Connect Garmin GPS to Computer” above if needed).
- Launch DNRGarmin, go to GPS → Set Port and select USB. Connection should be established.

6. If you’re using COM1 serial port and DNR Garmin is still not connecting to your GPS after performing step1-5 above, then follow these additional steps (written for Windows XP, may be slightly different for other Windows operating systems):
    - Close DNR Garmin, ArcGIS and turn off GPS unit. You may leave GPS unit connected to the COM1 serial port.
    - Click on Start → Control Panel → Performance and Maintenance → Administrative Tools.
    - Double-Click Computer Management.
    - Double-Click Device Manager.
    - Open up Ports and select COM 1.
    - Right mouse over COM 1 and select Disable.
    - Say yes to really disable this.
    - Press OK or Apply all the way out to close all windows.
    - Restart your computer.
    - When the computer is rebooted, Windows will re-establish the COM1 port. Proceed to step 1 of section “Connect GPS Receiver to COMPUTER” of this document.

Other Trouble Shooting Tips

3. You must have administrative privileges to install DNRGarmin software in the C:/Program Files directory on your computer. Contact your system administrator if installation was stalled because of installation rights.
4. If you have an earlier version of the DNR Garmin program on your machine you MUST uninstall before installing the new version. Uninstall previous versions by using the Start → Control Panel → Add/Remove Programs tool.
5. ActiveSync software (for use with Trimble GPS) often conflicts with DNR Garmin or other software needing access to a serial port. You may need to exit or disable ActiveSync on your computer first before using DNR Garmin.
6. For other installation errors please refer to Minn. DNR Help page at http://thoreau.dnr.state.mn.us/mis/gis/tools/arcview/Training/WebHelp/Training.htm#DNRExt/DNRGarmin4/GPSIntro.htm

Standard Operation Procedure (SOP) #6:
Using the Ricoh GPS Camera

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

1. Load camera memos onto Ricoh camera prior to sampling trip. Example memos:

<u>Stream Memos for KALA</u>

Park:
KALA

Stream:
Waikolu

Site:
FKALA01
FKALA02
FKALA03
FKALA04
FKALA06
FKALA07
FKALA08
FKALA09
TKALA10
TKALA11
TKALA12
TKALA13
TKALA14
TKALA15
TKALA16
TKALA17

Transect Number:
1
2
3

Direction:
Upstream

Downstream
Right Bank
Left Bank

Photographer: Anne Farahi
Tahzay Jones

2. Perform compass calibration procedure each time you move the camera more than 100 miles as instructed in Ricoh Instruction Manual.
3. Turn on Ricoh camera and allow enough time for the GPS receive signals from at least four satellites. Wait until you see *3D fix* displayed on the camera's display; this indicates that the GPS is receiving at least four satellite signals and can accurately map your location. A GPS point of where you are standing when the photo is taken will automatically be collected when you take a picture.
4. Be careful to not block the GPS receiver when taking photos. The GPS receiver says "GPS" and has a small antenna that extends beyond the camera body.
5. Photos should be taken from the center of each transect facing upstream, downstream, and towards the right and/or left bank if noteworthy.
6. Select the appropriate field for each memo by pressing the ad/memo button. Select ok to set memo.
7. Wait for *3D fix* on the camera's display. Take picture. Repeat for each direction at each transect.

Standard Operation Procedure (SOP) #7:
Training Field Personnel

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes general qualifications and training procedures for implementing the *Pacific Islands Stream Monitoring: Fish, Shrimp, Snails and Habitat Characterization* protocol. Training may be conducted on a yearly basis by experienced PACN staff, for example the Aquatic Ecologist. In line with other monitoring programs, such as the USGS NAWQA program, periodic training (every three to five years) and review of the SOPs should be conducted in conjunction with other experts (for example the authors of the protocol).

Review the protocol

The first step of the training procedure is to thoroughly read and understand the protocol and especially the associated SOPs. All persons doing fieldwork should read the protocol prior to beginning sampling, and should periodically review it (at a minimum it should be reread each year). Field crews should always carry a copy of all the SOPs describing the field activities for the location they will be sampling.

Species identification

For snorkeling surveys, all crew members doing sampling must be able to identify fish by sight. Because shrimp and snails are collected, identification of these organisms can be done using field guides. Currently, atyid shrimp in Guam are sent to a laboratory for identification, so crew members do not need to be able to identify them.

The first step in learning to identify the fish, shrimp, and snails that will be surveyed occurs in the office. Crew members should familiarize themselves with the entire native and introduced organisms that they are likely to observe at the sampling site. Appendices

#1-4 provide pictures to assist in species identification and training. Waterproof copies of these appendices should be carried in the field. Initially new crew members should review the species on their own, and then receive training from an experienced observer on key characteristics to assist in identification in the field.

The second step occurs in the field. Prior to conducting any surveys, all new crew members should pair up with an experienced observer and work together on identifying the species they observe while snorkeling in a reach of the stream that will not be part of the actual sampling.

Conducting faunal surveys

Steps for conducting surveys are covered in detail in SOPs #8-21. Initially new crew members should review the SOPs on their own, and then receive training in the office prior to going to the field. Additional training on conducting surveys should occur at a field site. Finally, prior to beginning the sampling each year, all steps for conducting surveys for each taxonomic group should be practiced in a reach of the stream that will not be part of the sampling. Training for conducting surveys should include not only the actual surveying of fish, shrimp, and snails, but also proper data entry and field checking of data sheets.

Conducting habitat assessments

Steps for conducting habitat assessments are covered in detail in SOP #23: "Habitat Characterization at the Reach and Transect Scales." Initially new crew members should review the SOPs on their own, and then receive training in the office prior to going to the field. Additional training on habitat assessments should occur at a field site. Finally, prior to beginning the sampling each year, all steps for making habitat measurements should be practiced in a reach of the stream that will not be part of the sampling. Training for conducting surveys should include not only the actual habitat measurements, but also proper data entry and field checking of data sheets.

Data Management

All persons involved with any aspect of data management should review Chapter 4 and SOPs #25-31. Each year an in-office training should be conducted by the PACN data manager, to review all data management activities.

Data Analysis and Reporting

All persons involved with any aspect of data analysis and reporting should review Chapter 4 and SOP #32: "Data Analysis and Reporting". An example report is provided in Appendix #15: "Pacific Islands Stream Monitoring Report: Example Summary of Vital Signs Data." Assistance with data analysis and reporting efforts can be provided by the PACN aquatic ecologist and authors of this protocol.

Other training

All crew members should be certified in first aid and CPR. A range of other training is available nationally; from wilderness first aid and swift water rescue to advanced statistical techniques for data analysis.

Standard Operation Procedure (SOP) #8:
Conducting Surveys on Tau, American Samoa

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose
This Standard Operating Procedure describes setting up a sampling station (reach) and the general sampling order. This SOP will be used in American Samoa on the island of Tau at NPSA.

Conducting surveys on Tau
1. *Mark the reach*. Each reach is thirty meters long following the thalweg of the stream. The start of the reach (0 m) is marked with flagging tape on the bank where the mark can be easily seen from the stream. Locations are then marked at 15 m and 30 m. At this point, it is also useful to divide the reach into five sections for the shrimp surveys, therefore, sections will be also be marked at 6 m, 12 m, 18 m, and 24 m. It is important not to enter the stream when marking the reach. If it is impossible not to enter the stream at any point during this procedure, stop and wait for the fish and shrimp observers to finish their surveys before continuing to mark the reach.
2. *Mark the location using a Global Positioning System (GPS)*. See SOP #4: “Using Garmin Global Positioning System (GPS) Units.”
3. *Conduct water quality sampling.* See Water Quality Monitoring Protocol. Water quality nutrient samples and physical parameters are taken at the top of the reach above the 30 m mark. Nutrient samples are taken only at fixed sampling stations. Physical parameters are recorded at all fixed and temporary sampling stations.
4. *Conduct the fish survey*. See SOP #12: “Fish Surveys on Tau, American Samoa.” It is important that the fish observers are the only people in the water while conducting a survey in a given area.

5. *Conduct the shrimp survey*. See SOP #13: “Shrimp (ula vai) Surveys on Tau, American Samoa”. It is important that the shrimp observers are the only people in the water while conducting a survey in a given area.
6. *Conduct the snail survey*. See SOP #14: “Snail (sisi vai) Surveys on Tau, American Samoa.” Snail observers use the same coordinate locations as the fish observers. They work from downstream to upstream.
7. *Conduct the habitat survey*. See SOP #23: “Habitat Characterization at the Reach and Transect Scales.”

Standard Operation Procedure (SOP) #9:
Conducting Surveys on Tutuila, American Samoa

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and the general sampling order. This SOP will be used in American Samoa on the island of Tutuila at NPSA.

Conducting surveys on Tutuila

1. *Mark the reach*. Each reach is thirty meters long following the thalweg of the stream. The start of the reach (0 m) is marked with flagging tape on the bank where the mark can be easily seen from the stream. Locations are then marked at 15 m and 30 m. At this point, it is also useful to divide the reach into five sections for the shrimp surveys, therefore, sections will be also be marked at 6 m, 12 m, 18 m, and 24 m. It is important not to enter the stream when marking the reach. If it is impossible not to enter the stream at any point during this procedure, stop and wait for shrimp observers to finish their surveys before continuing to mark the reach.
2. *Mark the location using a Global Positioning System (GPS)*. See SOP #4: "Using Garmin Global Positioning System (GPS) Units."
3. *Conduct water quality sampling.* See Water Quality Monitoring Protocol. Water quality nutrient samples and physical parameters are taken at the top of the reach above the 30 m mark. Nutrient samples are taken only at fixed sampling stations. Physical parameters are recorded at all fixed and temporary sampling stations.
4. *Snorkel surveys for fish are not conducted on the island of Tutuila.* Stream mouths are not safe for snorkeling due to potential contaminants from surrounding villages. Upstream regions are too shallow to utilize snorkel surveys. Fish

presence is noted on site datasheets; however, fish are only identified and measured if caught incidentally during shrimp survey.

5. *Conduct the shrimp survey*. See SOP #15: “Shrimp (ula vai) Surveys on Tutuila, American Samoa.” It is important that the shrimp observers are the only people in the water while conducting a survey in a given area.
6. *Conduct the snail survey*. See SOP #16: “Snail (sisi vai) Surveys on Tutuila, American Samoa.” Snail observers use the same coordinate locations as the fish and shrimp observers. They work from downstream to upstream
7. *Conduct the habitat survey*. See SOP #23: “Habitat Characterization at the Reach and Transect Scales.”

Standard Operation Procedure (SOP) #10:
Conducting Surveys in Guam

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and the general sampling order. This SOP will be used in Guam at WAPA.

Conducting surveys in Guam

1. *Mark the reach*. Each reach is thirty meters long following the thalweg of the stream. The start of the reach (0 m) is marked with flagging tape on the bank where the mark can be easily seen from the stream. The reach is then divided into five 6 meter sections, therefore, sections will be marked at 6 m, 12 m, 18 m, and 24 m, and 30 m. It is important not to enter the stream when marking the reach. If it is impossible not to enter the stream at any point during this procedure, stop and wait for the fish and shrimp observers to finish their surveys before continuing to mark the reach.
2. *Mark the location using a Global Positioning System (GPS)*. See SOP #4: "Using Garmin Global Positioning System (GPS) Units."
3. *Conduct water quality sampling.* See Water Quality Monitoring Protocol. Water quality nutrient samples and physical parameters are taken at the top of the reach above the 30 m mark. Nutrient samples are taken only at fixed sampling stations. Physical parameters are recorded at all fixed and temporary sampling stations.
4. *Conduct the fish survey*. See SOP #17: "Fish (atot) Surveys in Guam." It is important that the fish observers are the only people in the water while conducting a survey in a given area.
5. *Conduct the shrimp survey*. See SOP #18: "Shrimp (uhang) Surveys in Guam." It is important that the shrimp observers are the only people in the water while conducting a survey in a given area.

6. *Conduct the snail survey*. See SOP #19: “Snail (akaleha) Surveys in Guam.” Snail observers use the same coordinate locations as the fish observers. They work from downstream to upstream.
7. *Conduct the habitat survey*. See SOP #23: “Habitat Characterization at the Reach and Transect Scales.”

Standard Operation Procedure (SOP) #11:
Conducting Surveys in Hawaii

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose
This Standard Operating Procedure describes setting up a sampling station (reach) and the general sampling order. This SOP will be used in Hawaii on the island of Maui at HALE and on the island of Molokai at KALA.

Conducting surveys in Hawaii
1. *Mark the reach*. Each reach is thirty meters long following the thalwag of the stream. The start of the reach (0m) is marked with flagging tape on the bank where the mark can be easily seen from the stream. Locations are then marked at 15m and 30m. It is important not to enter the stream when marking the reach. If it is impossible not to enter the stream at any point during this procedure, stop and wait for the fish and shrimp observers to finish their surveys before continuing to mark the reach.
2. *Mark the location using a Global Positioning System (GPS)*. See SOP #4: “Using Garmin Global Positioning System (GPS) Units.”
3. *Conduct water quality sampling.* See Water Quality Monitoring Protocol. Water quality nutrient samples and physical parameters are taken at the top of the reach above the 30m mark. Nutrient samples are taken only at fixed sampling stations. Physical parameters are recorded at all fixed and temporary sampling stations.
4. *Conduct the fish and shrimp survey*. See SOP #20: “Fish (oopu) and Shrimp (opae) Surveys in Hawaii.” It is important that the fish and shrimp observers are the only people in the water while conducting a survey.
5. *Conduct the snail survey*. See SOP #21: “Snail (hihiwai) Surveys in Hawaii.” Snail observers use the same coordinate locations as the fish and shrimp observers. They work from downstream to upstream. The fish and shrimp

observer must be in a location where the snail observers will not disturb the fish. For instance, the snail observers cannot begin their survey until the fish and shrimp observer has finished their survey in a pool where the water would be disturbed with another person in the water.

6. *Conduct the habitat survey*. See SOP #23: “Habitat characterization at the Reach and Transect Scales.”

Standard Operation Procedure (SOP) #12:
Fish Surveys on Tau, American Samoa

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

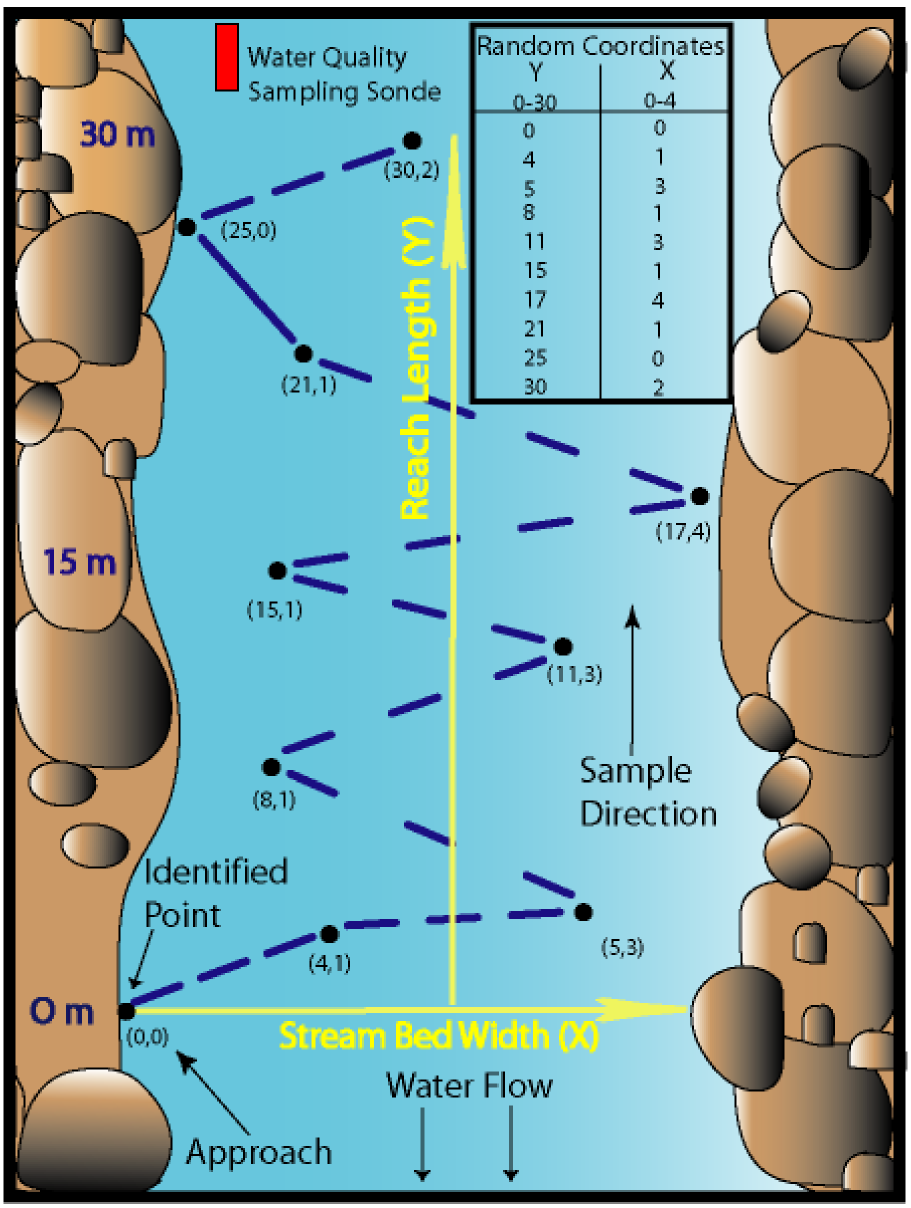
Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose
This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a snorkeling survey for fish using a quadrat sampling design. This SOP will be used in American Samoa on the island of Tau at NPSA.

Overview of sampling procedure
This procedure must be done first before other observers enter the water so as to minimize disturbance to fish prior to sampling. Sampling moves from downstream to upstream. A total of ten quadrats per reach will be surveyed. With two available observers, two observers will conduct surveys simultaneously, one sampling six quadrats and the other sampling four quadrats. With one observer available, the observer moves upstream to sample all ten quadrats. Observer(s) identify and size/count all fish in the quadrat in three minutes. Datasheets are included in Appendix #9: “Data Sheets: American Samoa.”

Conducting a survey for fish
Within each reach ten random number pairs are generated using the Cartesian coordinate system. The Y coordinate represents the distance in meters upstream between 0 and 30 (see Figure S.12.1). The X coordinate represents the distance in meters across the stream and varies depending on the maximum width of the stream. This is done to avoid over sampling the edges of the stream. X coordinates for the stream on Tau should be between 0 and 4. Coordinates should be ordered (Y, X) starting with Y=0 to facilitate movement upstream. When facing upstream, 0 begins on the left bank. For example, a quadrat location of (4,2) would be paced four meters upstream and two meters to the right of the left bank when facing upstream. To count fish, an observer unobtrusively paces off the

meters to the appropriate quadrat location. Always approaching from downstream, the observer carefully and quietly lowers into the water and, using mask and snorkel, moves slowly toward the quadrat location. A one-meter-long thin metal wire is used to determine the exact boundaries of the quadrat. The observer should lie as still as possible for two minutes prior to beginning the survey in order to allow fish to return to the quadrat. The observer records all fish within the quadrat during a three-minute time period, noting species and size (total length from tip of nose to tip of tail) in cm. Observer then proceeds to the next coordinate location by snorkeling slowly through the water. Repeat procedure until all ten locations have been sampled.



Y 0-30	X 0-4
0	0
4	1
5	3
8	1
11	3
15	1
17	4
21	1
25	0
30	2

Figure S.12.1: Snorkel survey sampling procedure on Tau.

Both native and introduced species should be noted within a quadrat. Additionally, if an introduced species is seen in the stream, but is not in a quadrat it should be identified and noted on the datasheet in a separate location. In general, introduced fish should be collected and removed from the stream. If the species is not previously known from that area it should be vouchered. If an introduced species is not able to be identified observers should catch the specimen for expert identification.

Standard Operation Procedure (SOP) #13:
Shrimp (ula vai) Surveys on Tau, American Samoa

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a sectional shrimp survey. This SOP will be used in American Samoa on the island of Tau in NPSA.

Overview of procedure

Sampling moves from downstream to upstream. The 30 m reach will be divided into five sections each measuring six m. Sampling requires two observers collecting shrimp using dip nets and/or opae nets as available. The same observers, or other observers if available, measure and identify shrimp and record data. Datasheets are included in Appendix #9: "Data Sheets: American Samoa."

Conducting a survey for shrimp

The 30 m reach is divided into five six meter sections. Two observers utilize dip nets and/or opae nets to catch as many shrimp as possible within a fifteen minute time period in a given section. Observers can use a variety of strategies to catch shrimp depending on the environment. One strategy would be to place the net downstream of a cascade and stir up the substrate upstream of the net to dislodge smaller shrimp. Another strategy is to pick up smaller rocks and leaves, as smaller atyid shrimp tend to hide under debris, and guide shrimp into nets. Larger crustaceans can also be found in deeper pools. Observers should sample a variety of substrate types to maximize the species diversity sampled. Observers will need to carefully inspect each piece of debris (rock, leaf, stick, etc) scooped up by the net in order to find shrimp. Shrimp can be as small as three cm and relatively clear, therefore, net contents must be inspected thoroughly. Shrimp caught within a section should be placed in a bucket with water from the site. Larger crustaceans

(*Macrobrachium sp*) and other shrimp that can be readily identified should be measured in terms of total length (from tip of the rostrum to the tip of the tail). Once identified and measured, shrimp should be returned to the stream. All other atyid shrimp that cannot be confidently identified in the field are to be collected and placed in a marked sample jar containing ethanol for later lab identification and analysis.

Introduced species

Introduced species should be noted on the datasheet. In general, introduced fish should be collected and removed from the stream. If the species is not previously known from that area it should be vouchered. If an introduced species is not able to be identified observers should catch the specimen for expert identification.

Standard Operation Procedure (SOP) #14:
Snail (sisi vai) Surveys on Tau, American Samoa

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a snail survey using a quadrat sampling design. This SOP will be used in American Samoa on the island of Tau at NPSA

Overview of procedure

Sampling moves from downstream to upstream. A total of ten quadrats per reach will be surveyed. Sampling requires one observer collecting snails, and a second observer measuring snails and recording data. The observers first count egg capsules in a ¼ m^2 area. The observers then proceed to collect and measure all snails, and count all post-larval snails called spat that measure less than 5 mm in the 1 m^2 quadrat. Datasheets are included in Appendix #9: "Data Sheets: American Samoa."

Conducting a survey for snails

Within each reach, ten random number pairs are generated using the Cartesian coordinate system. These number pairs are the same coordinates used to conduct the fish surveys. The Y coordinate represents the distance in meters upstream between 0 and 30. The X coordinate represents the distance in meters across the stream and varies depending on the maximum width of the stream. X coordinates for streams on Tau should be between 0 and 4. Coordinates should be ordered using the Y coordinate starting with 0 to facilitate movement upstream. When facing upstream, 0 begins on the left bank. To count snails each observer paces off the meters to the appropriate quadrat location based on the coordinate system and uses a thin one meter long metal wire to determine the exact boundaries of the 1 m^2 quadrat. The observer first counts all the eggs visible or under rocks in the bottom left ¼ of the plot frame. Wearing a face mask and snorkel, the observer collects all snails (visible or located between and beneath boulders) within the quadrat and measures them with calipers. As demonstrated in Figure S.14.1, shell lengths are measured to the nearest millimeter, as the longest distance between the apex (origin of whorl) and the anterior margin (Ford 1979). All loose gravel, cobble, and rocks are then removed and additional snails found within the quadrat are collected and measured. Snails are returned to the stream after being measured. Place the snail so that it can reattach to the substrate; don't just toss it back in or it may be eaten by a prawn. The number of post-larval snails [any snail ≤ 5 mm (Ford 1979; Hodges 1992)] within each quadrat is also recorded (counted).

Figure S.14.1. Measure the snail as the longest distance from the apex of the shell to the anterior margin (indicated by the pink line).

Standard Operation Procedure (SOP) #15:
Shrimp (ula vai) Surveys on Tutuila, American Samoa

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a sectional shrimp survey. This SOP will be used in American Samoa on the island of Tutuila in NPSA.

Overview of procedure

Sampling moves from downstream to upstream. The 30 m reach will be divided into five sections each measuring 6 m. Sampling requires two observers collecting shrimp using dip nets and/or opae nets. The same observers, or other observers if available, measure and identify shrimp and record data. Datasheets are included in Appendix #9: "Data Sheets: American Samoa."

Conducting a survey for shrimp

The 30 m reach is divided into five 6 m sections. Two observers utilize dip nets and/or opae nets to catch as many shrimp as possible within a fifteen minute time period in a given section. Observers can use a variety of strategies to catch shrimp depending on the environment. One strategy would be to place the net downstream of a cascade and stir up the substrate upstream of the net to dislodge smaller shrimp. Another strategy is to pick up smaller rocks and leaves, as smaller atyid shrimp tend to hide under debris, and guide shrimp into nets. Larger crustaceans can also be found in deeper pools. Observers should sample a variety of substrate types to maximize the species diversity sampled. Observers will need to carefully inspect each piece of debris (rock, leaf, stick, etc) scooped up by the net in order to find shrimp. Shrimp can be as small as 3 mm and relatively clear, therefore, net contents must be inspected thoroughly. Shrimp caught within a section should be placed in a bucket with water from the site. Larger crustaceans (*Macrobrachium sp*) and other shrimp that can be readily identified should be measured in terms of total length (from tip of the rostrum to the tip of the tail). All other atyid shrimp that cannot be confidently identified in the field are to be collected and placed in a marked sample jar containing ethanol for later lab identification and analysis. Note quantity of shrimp placed in sample jar on datasheet.

Standard Operation Procedure (SOP) #16:
Snail (sisi vai) Surveys on Tutuila, American Samoa

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a snail survey using a quadrat sampling design. This SOP will be used in American Samoa on the island of Tutuila at NPSA

Overview of procedure

Sampling moves from downstream to upstream. A total of ten quadrats per reach will be surveyed. Sampling requires one observer collecting snails, and a second observer measuring snails and recording data. The observers first count egg capsules in a ¼ m^2 area. The observers then proceed to collect and measure all snails, and count all post-larval snails called spat that measure less than 5 mm in the 1 m^2 quadrat. Datasheets are included in Appendix #9: "Data Sheets: American Samoa."

Conducting a survey for snails

Within each reach, ten random number pairs are generated using the Cartesian coordinate system. The Y coordinate represents the distance in meters upstream between 0 and 30. The X coordinate represents the distance in meters across the stream and varies depending on the maximum width of the stream. X coordinates for streams on Tutuila should be between 0 and 4. Coordinates should be ordered using the Y coordinate starting with 0 to facilitate movement upstream. When facing upstream, 0 begins on the left bank. To count snails each observer paces off the meters to the appropriate quadrat location based on the coordinate system and uses a thin one meter long metal wire to determine the exact boundaries of the 1 m^2 quadrat. The observer first counts all the eggs visible or under rocks in the bottom left ¼ of the plot frame. Wearing a face mask and snorkel, the observer collects all snails (visible or located between and beneath boulders) within the quadrat and measures them with calipers. As demonstrated in Figure S.16.1, shell lengths are measured to the nearest millimeter, as the longest distance between the apex (origin of whorl) and the anterior margin (Ford 1979). All loose gravel, cobble, and rocks are then removed and additional snails found within the quadrat are collected and measured. Snails are returned to the stream after being measured. Place the snail so that it can reattach to the substrate; don't just toss it back in or it may be eaten by a prawn. The number of post-larval snails [any snail ≤ 5 mm (Ford 1979; Hodges 1992)] within each quadrat is also recorded (counted).

Figure S.16.1. Measure the snail as the longest distance from the apex of the shell to the anterior margin (indicated by the pink line).

Standard Operation Procedure (SOP) #17:
Fish (atot) Surveys in Guam

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a snorkeling survey for fish using a quadrat sampling design. This SOP will be used in Guam at WAPA.

Overview of sampling procedure

This procedure must be done first before other observers enter the water so as to minimize disturbance to fish prior to sampling. Sampling moves from downstream to upstream. A total of ten quadrats per reach will be surveyed. With two available observers, two observers will conduct surveys simultaneously, one sampling six quadrats and the other sampling four quadrats. With one observer available, the observer moves upstream to sample all ten quadrats. Observer(s) identify and size/count all fish in the quadrat in three minutes. Datasheets are included in Appendix #10: "Data Sheets: Guam."

Conducting a survey for fish

Within each reach ten random number pairs are generated using the Cartesian coordinate system. The Y coordinate represents the distance in meters upstream between 0 and 30 (see Figure S.17.1). The X coordinate represents the distance in meters across the stream and varies depending on the maximum width of the stream. This is done to avoid over sampling the edges of the stream. X coordinates for the stream on Tau should be between 0 and 4. Coordinates should be ordered (Y, X) starting with Y=0 to facilitate movement upstream. When facing upstream, 0 begins on the left bank. For example, a quadrat location of (4,2) would be paced four meters upstream and two meters to the right of the left bank when facing upstream. To count fish, an observer unobtrusively paces off the meters to the appropriate quadrat location. Always approaching from downstream, the observer carefully and quietly lowers into the water and, using mask and snorkel, moves slowly toward the quadrat location. A one-meter-long thin metal wire is used to determine the exact boundaries of the quadrat. The observer should lie as still as possible for two minutes prior to beginning the survey in order to allow fish to return to the quadrat. The observer records all fish within the quadrat during a three-minute time period, noting species and size (total length from tip of nose to tip of tail) in cm. Eels (asuli) as well as introduced fish should also be identified, sized, and noted on the datasheet. Observer then proceeds to the next coordinate location by snorkeling slowly through the water. Repeat procedure until all ten locations have been sampled.

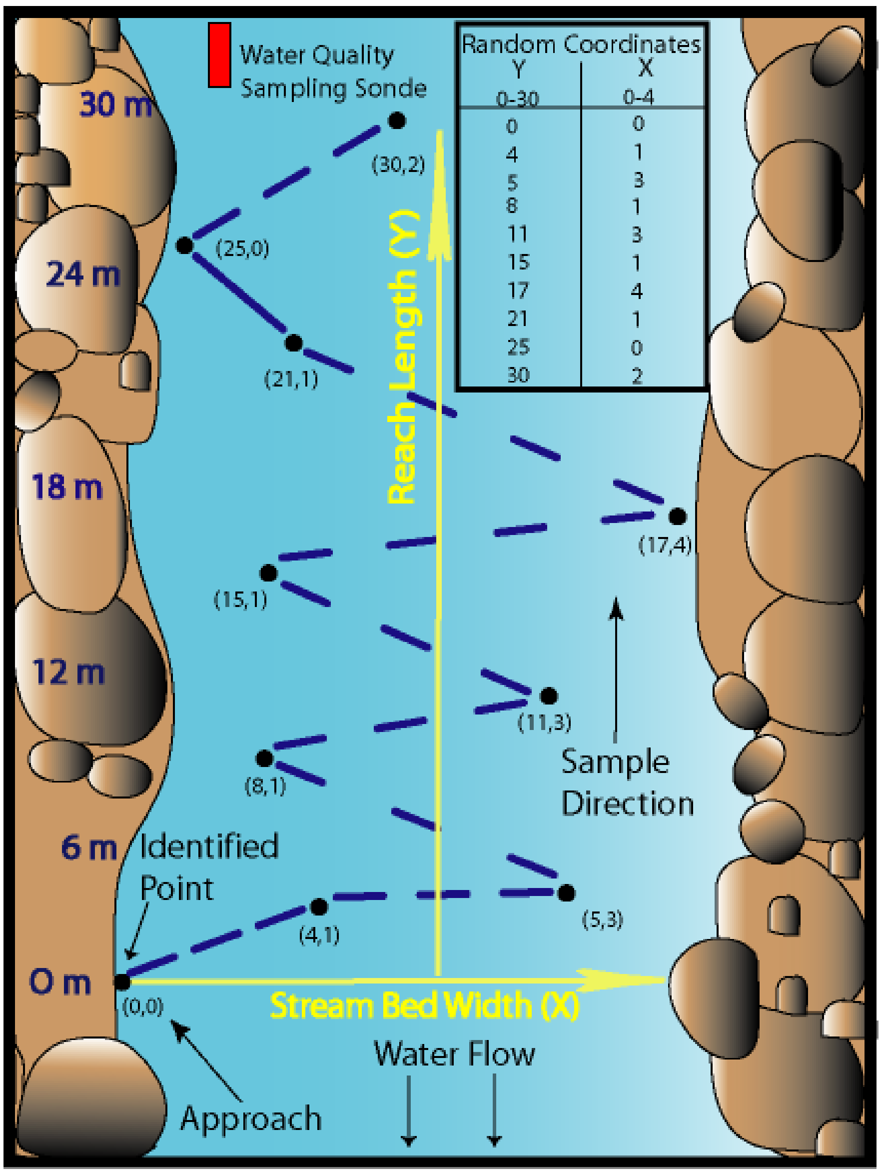


Figure S.17.1. Conducting fish surveys in Guam.

Introduced species

Both native and introduced species should be noted within a quadrat. Additionally, if an introduced species is seen in the stream, but is not in a quadrat it should be identified and noted on the datasheet in a separate location. In general, introduced fish should be collected and removed from the stream. If the species is not previously known from that area it should be vouchered. If an introduced species is not able to be identified observers should catch the specimen for expert identification.

Standard Operation Procedure (SOP) #18:
Shrimp (uhang) Surveys in Guam

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a sectional shrimp survey. This SOP will be used in Guam at WAPA.

Overview of procedure

Sampling moves from downstream to upstream. The 30 m reach will be divided into five sections each measuring 6 m. Sampling requires an observer collecting shrimp using an opae net or dip net as available. Another observer measures and identifies larger crustaceans (*Macrobrachium lar*) and counts smaller atyid shrimp and places them in marked sample jars filled with ethanol for later identification. Datasheets are included in Appendix #10: “Data Sheets: Guam.”

Conducting a survey for shrimp

The 30 m reach is divided into five 6 m sections. One observer utilizes an opae net and/or dip net to catch shrimp using three targeted scoops per section. A targeted scoop is directed towards an area that appears to be suitable shrimp habitat. Generally, stream edges near areas with roots, leaves, and tree trunks tend to provide good hiding places for shrimp. Another strategy would be to place the net downstream of a cascade or riffle and stir up the substrate upstream of the net to dislodge smaller shrimp. Also, observers can pick up pebbles and leaves, as smaller atyid shrimp tend to hide under debris, and guide shrimp into nets. Larger crustaceans can also be found in deeper pools. Observers should sample a variety of substrate types to maximize the species diversity sampled. Observers will need to carefully inspect each piece of debris (rock, leaf, stick, etc) scooped up by the net in order to find shrimp. Shrimp can be as small as 3 cm and relatively clear, therefore, net contents must be inspected thoroughly. Shrimp caught within a section should be placed in a bucket with water from the site. Larger crustaceans (*Macrobrachium lar*) that can be readily identified should be measured in terms of total length (from tip of the rostrum to the tip of the tail) and returned to the stream. All other shrimp that cannot be confidently identified in the field are to be collected and placed in a marked sample jar containing ethanol for later lab identification and analysis.

Standard Operation Procedure (SOP) #19:
Snail (akaleha) Surveys in Guam

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a snail survey using a quadrat sampling design. This SOP will be used in Guam at WAPA.

Overview of procedure

Sampling moves from downstream to upstream. Five 6 m sections will be surveyed for snails. This method is a full sectional search. Sampling requires one or two observers collecting snails, and another observer onshore measuring snails and recording data. The observers count egg capsules, collect snails, and count all post-larval snails (spat) that measure less than 5 mm in each 6 m section. The onshore observer identifies and measures snails and records data. Datasheets are included in Appendix #10: "Data Sheets: Guam."

Conducting a survey for snails

Each of five 6 m sections will be completely surveyed for snails. Ideally two observers would be available to perform in-water counting and collecting simultaneously. One observer can search the right bank to the center of the stream and the other can search the left bank to the center of the stream in order to completely cover the stream. The in-water observers count egg capsules found on and between rocks using mask and snorkel if necessary. Observers should also pick up smaller rocks and count egg capsules that can often be found underneath rocks. Observers tell the onshore recorder the number of egg capsules counted per section. The in-water observers also count the number of post-larval snails [any snail $\leq$ 5 mm (Ford 1979; Hodges 1992)] within each section and inform the onshore data recorder. Wearing a face mask and snorkel, the observer collects all snails (visible or located between and beneath boulders) within the section and hands them to the onshore recorder to identify and measure them with calipers. As demonstrated in Figure S.19.1, shell lengths are measured to the nearest millimeter, as the longest distance between the apex (origin of whorl) and the anterior margin (Ford 1979). All loose gravel, cobble, and rocks are then removed and additional snails found within the section are collected and measured. Snails are returned to the stream after being measured. Place the snail so that it can reattach to the substrate; you may have to hold it in place for a short time, don't just toss it back in or it may be eaten by a prawn.

Figure S.19.1. Measure the snail as the longest distance from the apex of the shell to the anterior margin (indicated by the pink line).

Standard Operation Procedure (SOP) #20:
Fish (oopu) and shrimp (opae) surveys in Hawaii

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a snorkeling survey for fish and shrimp using a quadrat sampling design. This SOP will be used at in Hawaii on the island of Maui at HALE and on the island of Molokai at KALA.

Overview of sampling procedure

This procedure must be done first before other observers enter the water so as to minimize disturbance to fish and shrimp prior to sampling. Sampling moves from downstream to upstream. A total of ten quadrats per reach will be surveyed. With two available observers, two observers will conduct surveys simultaneously, one sampling six quadrats and the other sampling four quadrats. With one observer available, the observer moves upstream to sample all ten quadrats. Observer(s) identify and size/count all fish and shrimp in the quadrat in three minutes. Datasheets are included in Appendix #11: “Data Sheets: Hawaii.”

Conducting a snorkel survey for fish and shrimp

Within each reach ten random number pairs are generated using the Cartesian coordinate systems. The Y coordinate represents the distance in meters upstream between 0 and 30 (See Figure S.20.1). The X coordinate represents the distance in meters across the stream and varies depending on the maximum width of the stream. This is done to avoid oversampling the edges of the stream. X coordinates for streams in Hawaii should be between 0 and 7. Coordinates should be ordered using the Y coordinate starting with 0 to facilitate movement upstream. When facing upstream, 0 begins on the left bank. For example, a quadrat location of (4,2) would be paced four meters upstream and two meters to the right of the left bank when facing upstream. To begin the snorkel survey, an observer unobtrusively paces off the meters to the appropriate quadrat location. Always approaching from downstream, the observer carefully and quietly loers into the water and, using mask and snorkel, moves slowly toward the quadrat location. A one-meter-long thin metal wire is used to determine the exact boundaries of the quadrat. The observer should lie as still as possible to beginning the survey in order to allow fish to return to the quadrat. The observer records all fish and crustaceans within the quadrat during a three-minute period, noting species and size (total length from tip of nose to tip of tail) in centimeters. *Atyoida bisulcata* (Opae kala ole) are recorded as a total number of individuals with each quadrat

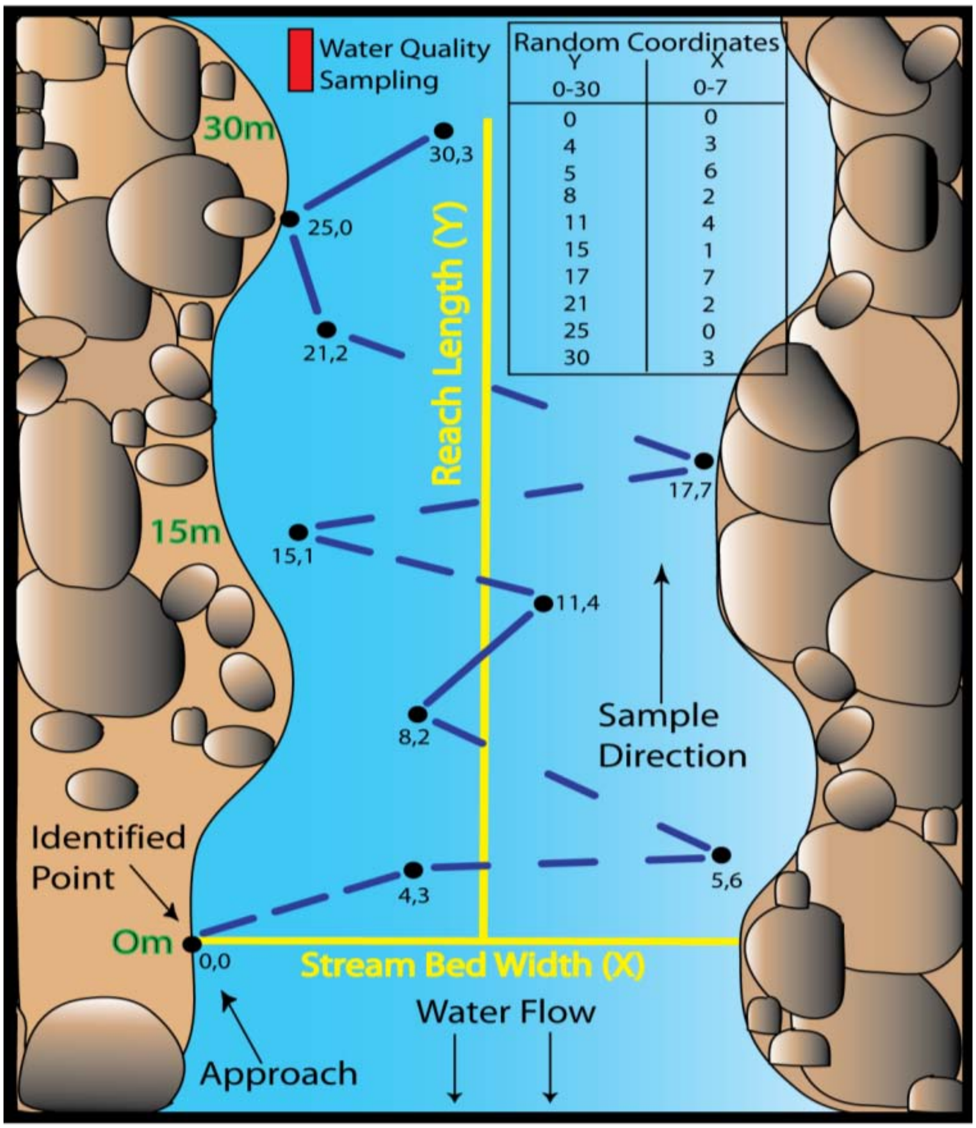


Figure S.20.1: Snorkel survey sampling procedure in Hawaii.

Conducting a survey in a pool

When a large pool is too deep or murky to see to the bottom, the edges are sampled. In this case, use the y coordinates of the already selected points to determine the location along the edge of the pool (see Figure S.20.2). Points should be as evenly divided between both sides of the pool as possible. If the pool encompasses the entire reach, then sample 5 quadrats on one side and 5 quadrats on the other. In this case, it is useful to have two observers though one observer can sample all locations if necessary. A one-meter-long thin metal wire is placed at the edge of the pool so that the survey location is a one meter square quadrat away from the edge. The observer enters the pool wearing mask and snorkel as quietly as possible to approach the first location. The observer should lie as still as possible for two minutes prior to beginning the survey in order to allow fish to return to the quadrat. The observer records all fish and crustaceans within the quadrat during a three-minute period, noting species and size (total length from tip of nose to tip of tail) in centimeters. *Atyoida bisulcata* (`O`pae kala`ole) are counted and recorded as a total number of individuals within each quadrat. If the pool does not encompass the entire reach, all points after the end of the pool are treated normally. For example, if the pool is twenty meters long and sites with a y coordinate greater than 20 would be sampled as stated in the above paragraph.

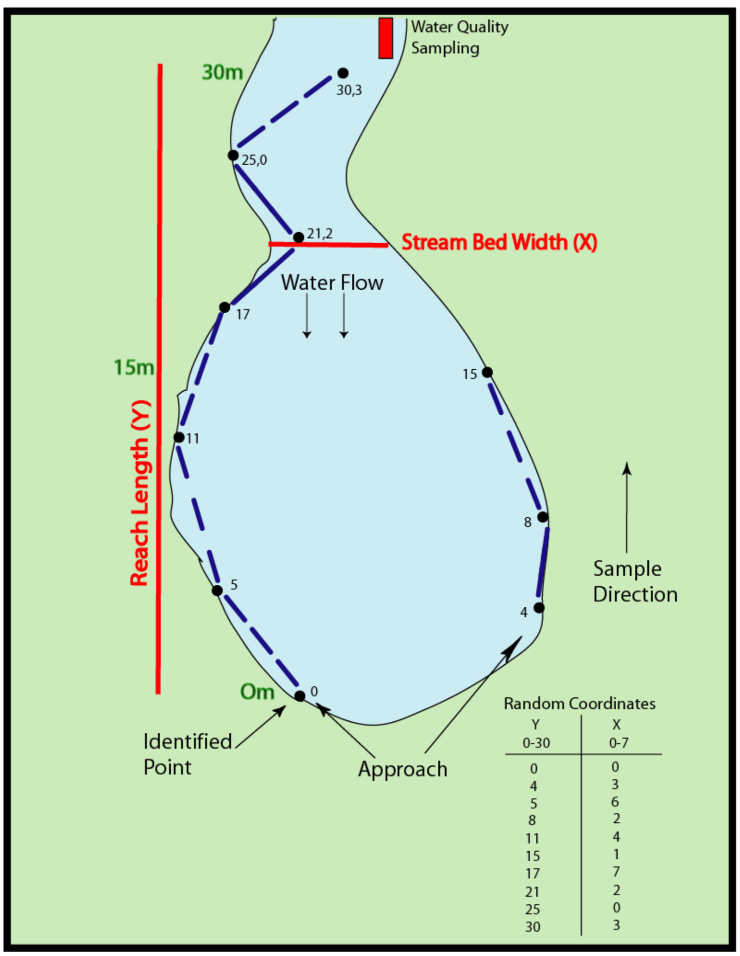


Figure S.20.2. Snorkel survey in deep pool in Hawaii.

Introduced species

Both native and introduced species should be noted within a quadrat. Additionally, if an introduced species is seen in the stream, but is not in a quadrat it should be identified and noted on the datasheet in a separate location. In general, introduced fish should be collected and removed from the stream. If the species is not previously known from that area it should be vouchered. If an introduced species is not able to be identified observers should catch the specimen for expert identification.

Standard Operation Procedure (SOP) #21:
Snail (hihiwai) Surveys in Hawaii

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose
This Standard Operating Procedure describes setting up a sampling station (reach) and conducting a snail survey using a quadrat sampling design. This SOP will be used in Hawaii on the island of Maui at HALE and on the island of Molokai at KALA.

Overview of procedure
Sampling moves from downstream to upstream. A total of 10 quadrats per reach will be surveyed. Sampling requires one observer collecting snails, and a second observer measuring snails and recording data. The observers first collect and measures all snails, and count all post-larval snails called spat that measure less than 5mm then proceed to an adjacent area to count egg capsules. Datasheets are included in Appendix #11: "Data Sheets: Hawaii."

Conducting a survey for snails
Within each reach ten random number pairs are generated using the Cartesian coordinate system. These number pairs are the same coordinates used to conduct the fish and shrimp surveys. The Y coordinate represents the distance in meters upstream between 0 and 30. The X coordinate represents the distance in meters across the stream and varies depending on the maximum width of the stream. X coordinates for streams in Hawaii should be between 0 and 7. Coordinates should be ordered using the Y coordinate starting with 0 to facilitate movement upstream. When facing upstream, 0 begins on the left bank. To count snails each observer paces off the meters to the appropriate quadrat location based on the coordinate system and places a thin wire ¼ m^2 quadrat plot frame on the stream bed. Wearing a face mask and snorkel, the observer collects all snails (visible or

located between and beneath boulders) within the quadrat and measures them with calipers. As demonstrated in Figure S.21.1, shell lengths are measured to the nearest millimeter, as the longest distance between the apex (origin of whorl) and the anterior margin (Ford 1979). All loose gravel, cobble, and rocks are then removed and additional snails found within the quadrat are collected and measured. Snails are returned to the stream after being measured. Place the snail so that it can reattach to the substrate; don't just toss it back in or it may be eaten by a prawn. The number of post-larval snails [any snail $\leq$ 5 mm (Ford 1979; Hodges 1992)] within each quadrat is also recorded (counted). After all snails in each quadrat are measured, the quadrat is flipped upstream and to the right once in order to count unhatched egg capsules in an undisturbed 156 cm^2 quadrat (one-quarter of the plot frame).

Figure S.21.1. Measure the snail as the longest distance from the apex of the shell to the anterior margin (indicated by the pink line).

Standard Operation Procedure (SOP) #22:
Electrofishing for fish and crustaceans

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes methods for using electrofishing to sample fish and crustaceans on Tutuila (NPSA) and at WAPA. This is an optional activity, and its use will be determined by the PACN Aquatic Ecologist. At this time, electrofishing is not being used for monitoring following this protocol. Also, for this protocol, no electrofishing will occur on Tau or in Hawaii.

Overview of procedure

Electrofishing requires a crew trained in both sampling techniques and safety procedures. At least one crew member is required to have official training and certification for electrofishing. All crew members must be certified in first aid and CPR. One person wears the electrofisher, and two people collect fish and shrimp with large nets. Sampling moves from downstream to upstream. The sampling reach for electrofishing is the same reach where all other monitoring activities will occur. Additional information about electrofishing is available in the Western EMAP protocol (Peck et al. 2006) and in the Fisheries Techniques book (Nielsen and Johnson 1983). It is recommended that all crew members who will electroshock read the chapter on Electrofishing by James Reynolds in the Fisheries Techniques book. Information in this SOP comes primarily from Peck et al. 2006. The objective of this type of survey is to collect a representative sample of all except very rare species in the assemblage. It is not to collect all individuals within the reach. Sampling effort is allocated along the entire length of the reach. Backpack electrofishers are used as the sampling gear.

Importance of safety during electrofishing

The use of electrofishing gear to collect fish and shrimp requires training to do it safely and correctly to reduce the potential for injury or mortality to both humans and the animals being collected. Primary responsibility for safety while electrofishing rests with the sampling team leader. Electrofishing units can deliver a fatal electrical shock. While electrofishing, avoid contact with water unless sufficiently insulated against electrical shock. Use chest waders with nonslip soles and heavy rubber “linesmen” gloves. If you perspire heavily, wear polypropylene or other wicking and insulating clothing instead of cotton. If it is necessary for a team member to reach into the water to pick up something that was dropped, do so only after the electrical current is off and the anode is removed from the water. Crew members should keep each other in constant view or communication while electrofishing.

Conducting an electrofishing survey

All people in the water should have on waders and gloves. One person wears the electrofisher and two persons carry long-handled nets (made specifically for electrofishing) to collect the fish. The netters position themselves one on each side, and about ½ meter downstream of the person wearing the electrofisher. If additional crew members are available they can help by carrying the buckets. Otherwise the netters are also responsible for the buckets. Each bucket is filled halfway with stream water. Once a bucket begins to get crowded with fish or shrimp a new bucket is used.

Begin sampling at the downstream end of the reach, and proceed in an upstream direction. Start the electrofisher, set the timer, and depress the switch to begin collecting organisms. It is important the settings on the electrofisher are adjusted properly to sample effectively and minimize injury and mortality. Be sure to sample all habitats. In these small streams a reach can be adequately sampled in about 30 minutes. Record voltage settings, pulse rate, and time of sampling on a data sheet (this information is all available on the electrofisher).

As fish and shrimp are temporarily stunned, the crew members scoop them up and place them in a bucket. While the organisms are being transferred to the bucket, the electrofisher should be off. Once the entire reach has been sampled, all of the fish and shrimp in the buckets are identified and measured, and then returned to the stream unharmed.

We do not recommend two or three pass sampling. One pass through the reach should be adequate to characterize the fauna and estimate population abundance.

Standard Operation Procedure (SOP) #23:
Habitat characterization at the reach and transect scales

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes the conducting of habitat characterization work in each reach and transect. This protocol is consistent with previously established habitat assessment techniques used by the national NAWQA and EMAP programs, and users can refer to those documents for additional information. See Fitzpatrick et al. 1998 for NAWQA protocols; (http://water.usgs.gov/nawqa/protocols/bioprotocols.html), and Section 7 in Peck et al. CITATION for EMAP protocols; (http://www.epa.gov/emap/html/pubs/docs/groupdocs/surfwatr/field/ewwsm_s7.pdf).

Datasheets are included in Appendices #9-11.

Figure S.23.1. Measuring habitat characteristics.

Procedures

The reach should capture the full sequence of geomorphic channel units that are present in the stream segment. Reach length corresponds to the sampling reach for the fauna (30 meters). If possible, all physical habitat measurements should be made at each site on the same day that faunal samples are conducted. Within each reach, six equally spaced transects will be established perpendicular to the direction of flow (Figure S.23.1). Habitat will be measured at three transects (transects 1, 3, and 5) in American Samoa, at all six transects in Guam, and at three transects (transects 1, 3, and 5) in Hawaii. Physical measurements of bank and riparian features and in-stream characteristics will be made at each transect.

Curvilinear reach length

The reach should capture the full sequence of geomorphic channel units that are present in the stream segment. Total reach length should be 30 meters. The curvilinear reach length is measured by following the path of the thalweg (the part of the stream with the deepest water and most flow). If there is no distinct thalweg, then follow the center of the channel. In order not to disturb the fish and shrimp, it is important to set up the reach ***following*** snorkeling surveys. If electrofishing is to occur in the reach, set up the reach from the bank (do not enter the water prior to the electrofishing survey).

Distance between transects (complete characterization)

Three equidistant transects are spaced evenly within each reach in American Samoa and Hawaii, whereas six equidistant transects are spaced evenly within each reach in Guam.

The distance between transects is the reach length (curvilinear reach length) divided by two in American Samoa and Hawaii and five in Guam. The distance between transects is measured by following the thalweg of the channel. If no thalweg is observable, follow the center of the channel. Mark each transect with flagging tape or flag.

Geomorphic channel units (GCU)

Measure and record the length and identity of all geomorphic channel units (See Appendices #9-11 for channel unit descriptions) along the length of the reach. Note on the field sheet the measurement units used to determine GCU lengths, and whether you started at the upstream or downstream end of the reach. This is typically the last step (to avoid unnecessarily disturbing the reach) in physical habitat characterization.

At each transect record:

1) Habitat type. Dominant geomorphic channel unit across the transect.

2) Wetted channel width. Record the distance between the left and right edges of the water.

3) Transect point measurements. Stretch a metric tagline or measuring tape from the left bank to the right bank, perpendicular to the direction of flow, and secure each end to the ground using a stake. Depth and velocity are recorded at the thalweg (deepest part of the channel) and four additional equidistant points along the transect.

    a. Distance from left edge of water. The distance from the transect point to the left edge (facing downstream) of water is recorded.
    b. Depth. The depth of the stream is recorded at each transect point. The depth is determined by measuring the distance between the water surface and the bed substrate. Depth is measured using a wading rod. Note whether the wading rod is in metric or English units.
    c. Velocity. The velocity at the sampling location is measured using a flow meter to record the 40-second average velocity of the water column. Record type of flow meter used on the data sheet. Velocity is recorded at 60% depth when the depth is less than one meter. When depths are greater than or equal to one meter, two velocity measurements are taken. One measurement is taken at 20% depth and the other at 80% depth. The two velocity measurements are then averaged.

4) Riparian canopy closure. Riparian canopy closure is measured at the bank on each side of the stream using a concave spherical densiometer (Figure S.23.2). The densiometer is modified by drawing a right angle on the mirror surface with an indelible marker At the stream edge, the densiometer is held on the transect line facing the bank, 30 cm from and 30 cm above the water’s edge. The measurement is made by counting the number of point intersections (maximum is 17) covered by vegetation (Figure S.23.3). Record this number on the data sheet. At transects that are less than one meter in wetted width, one reading is made is the center of

the stream. For the center measurements, the densiometer is held 30 cm above the water surface, halfway between the left and right edges of the water, while facing upstream.

It is extremely important to keep the densiometer in the same position for each reading. You may wish to use the measuring tape as a guide to maintain the densiometer in the same position relative to the water's edge as you rotate. It is also important to keep the densiometer level using the bubble level and to view the densiometer from the same angle with each reading. This can be accomplished by positioning yourself so that the top of your forehead appears in the top-center of the mirror as you make the reading.

Figure S.23.2. Using a spherical densiometer to measure riparian canopy closure.

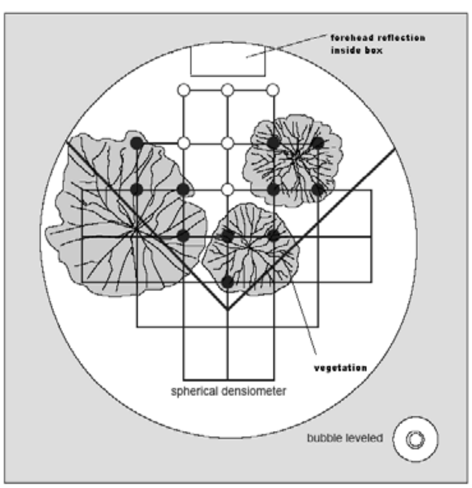


Figure S.23.3. A concave spherical densiometer.

Note the tape marking the right angle (above which points are counted) on the bubble level, and 17 points of intersection. Closed circles represent line intersections where vegetation is present and consequently counted in measurement of canopy closure, resulting in 11 out of 17 points (Fitzpatrick at el. 1998).

5) Pebble Count. The modified Wolman pebble count is a quantitative measurement of channel-substrate particle size. Across each transect, 20 pebbles should be collected and measured.
    a. Begin the pebble count at each transect at the wetted edge on the left bank and proceed to the wetted edge on the right bank.
    b. Divide the width of the transect by the number of pebbles to be measured to determine the interval length between points at which pebbles will be counted. If the channel is narrow, you may traverse the transect multiple times until twenty pebbles are measured; however, you must measure pebbles across the entire channel with each traverse.
    c. Using the measuring tape as a guide, aim your finger down vertically at each sampling point and pick up the first pebble that you touch. If the pebble is smaller than 0.1 cm, a value of "< 0.1cm" is recorded. If possible, differentiate between sand and silt.
    d. To reduce sampling bias, look across and not down at the channel bottom when retrieving the pebble.
    e. Measure each pebble across the longest axis.

Standard Operation Procedure (SOP) #24:
After Field Activities

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes procedures for the Project Lead Biological Technician to follow after the field season. There are four subsections of this SOP: (1) returning field equipment; (2) data sheets and data management; (3) summarizing field notes; and (4) reporting scientific collecting activities. Note that additional information regarding data management is provided in SOPs #25-34.

Procedures

Returning Field Equipment

1) Clean all equipment and gear before storage. Any problems with equipment or gear should be reported to the crew leader.

2) Sign in and store field equipment. The crew leader should sign in all gear that was issued at the beginning of the season. Any damaged equipment should be set aside to be repaired or replaced; all other equipment should be properly stored.

3) Repair or replace damaged equipment. When possible, damaged equipment should be repaired. Otherwise, damaged equipment should be replaced. The Project Lead is responsible for making sure that all necessary equipment is functional and accounted for before the next field season.

Data Sheets

Proofread data sheets. Proofread the data sheets to ensure that they are complete and legible. Although all data sheets should be reviewed for completeness in the field, some errors may not be identified until later.

1) Mark corrections on copied data sheets with red pen. Corrected errors and changes made on a data form should be circled using a red marker and initialed. A short explanation of the change should be included in the margin of that form.
2) Photocopy data sheets. Ensure that all original datasheets have been photocopied and that the originals and copies are stored in separate places.
3) Proofread copied data sheets. Proofread the copied datasheets to ensure that they are complete and legible.
4) Indicate corrections from originals on copied data sheets with red pen. Corrected errors and changes made on a data form should be circled using a red marker and initialed. A short explanation of the change should be included in the margin of that form.
5) Archive original data sheets. Organize and file data sheets by sampling location.
6) Create or update database log. Include the date and name of the technician entering data. Use the database log to keep notes on data entry, including suggestions for updates, errors encountered, and who entered or proofread the data.
7) Finish entering any remaining data into the appropriate database.
8) Proofread data entry. After the data have been entered, a different person should proofread the data from that year. Enter errors or changes into the database log.
9) Back up data entry files on an external drive that is periodically uploaded/exchanged by the data manager.

Summarizing Field Notes

1) Identify and store all photos from field season.
2) Photocopy the field notes from all crew members. Store the copies of the field notes with the original data sheets.
3) Compile trip reports from the sampling season. The crew leader should compile all sampling reports that were written during the sampling season.

Preparing samples for transport

1) Decant each specimen jar after 24 hours in 95% alcohol.
2) Refill specimen jar with 95% alcohol. You only need enough alcohol to cover the specimens (not the entire sample jar).
3) Decant each specimen jar a second time after 24 hours

4) Refill specimen jar with 95% alcohol and leave in alcohol until shipping is ready to begin. You only need enough alcohol to cover the specimens (not the entire sample jar).

5) Obtain export permit from the Fish and Wildlife Service. You will need to know approximately how many specimens of each type you will have.

6) Obtain a certificate of origin from the local government natural resources division.

7) Make copies of the collection permit, the FWS export permit, and the certificate of origin.

8) Call the lab specimens are being shipped to, so they can prepare to receive them. It is important to know how many samples, how many boxes, and when the samples will be expected to arrive.

9) Decant alcohol from the specimen jar and place cotton damp with alcohol in the specimen jar to gently fill the void.

10) Place in shipping box(s) along with collection permit, certificate of origin, and FWS export permit.

11) Call FWS to let them know the samples are being transported.

12) Mail package. It needs to arrive within 1 week from the last decanting. Lab will refill with alcohol and process.

Reporting Scientific Collecting Activities

1) Prepare and submit reports. Prepare and submit reports for all scientific collecting activities via the NPS Research Permit and Reporting System (RPRS) website http://science.nature.nps.gov/research. In addition, prepare and submit a report for the appropriate state or territorial agency.

Standard Operation Procedure (SOP) #25:
Workspace Setup and Project Records Management

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes how to set up a project workspace, and describes the PACN Digital Library which is used for archival of finished Pacific Islands Stream Monitoring Protocol: Fish, Shrimp, Snails, and Habitat Characterization products.

Set up project workspace

A section of the networked PACN file server is reserved for this project, and access permissions are established so that project staff members have access to needed files within this workspace. Prior to each season, the Project Lead should make sure that network accounts are established for each new staff member, and that the Data Manager is notified to ensure access to the project workspace and databases. If network connections are too slow for efficient data entry and processing, individual staff members may set up a workspace on their own workstation, with periodic data transfer to the PACN server. Daily back ups of the workstation to an external hard drive will ensure that no data is lost.

The recommended file structure within this workspace is shown in Figure 1. Certain folders – especially those for GPS data and images – should be retained in separate folders for each calendar year as shown in Figure S.25.1. This will make it easier to identify and move these files to the project archives at the end of each season (see Chapter 4: Season Close-out).

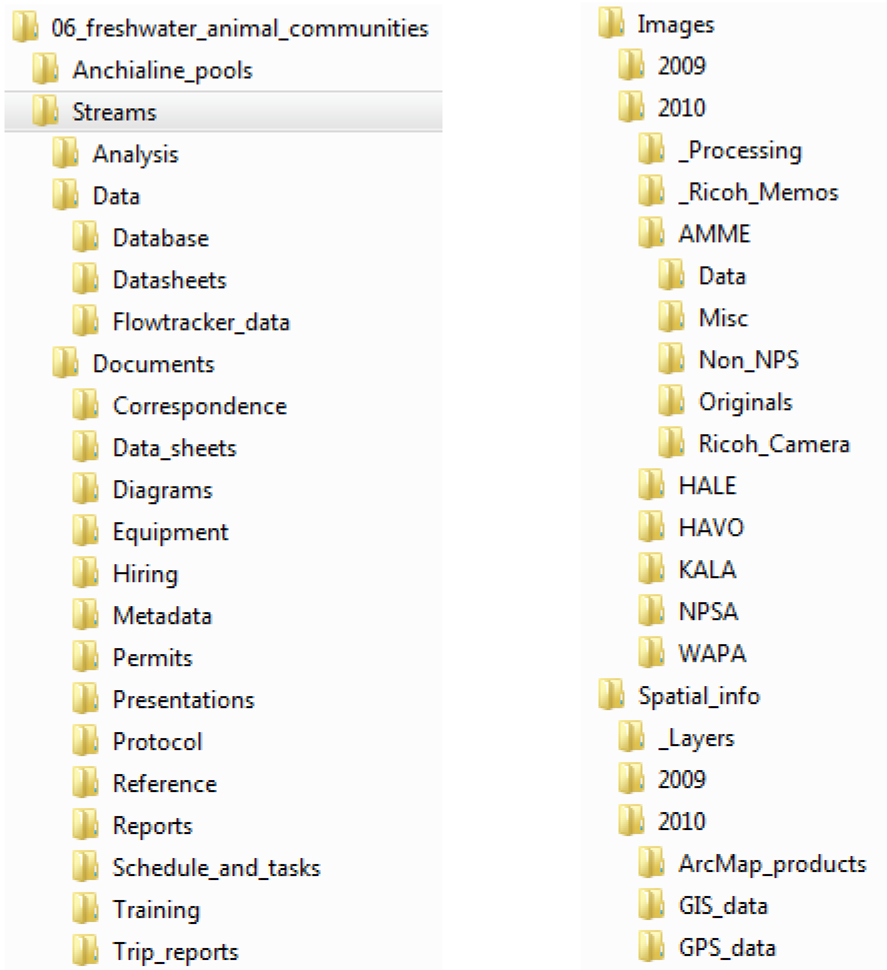


Figure S.25.1. Recommended file structure for the Freshwater Animal Communities, Streams project workspace.

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Images that are to be linked to the database have to be in the folders as designated in Figure 2. This will insure that when the images and database are moved that the links to the files will be updated in the database. The database must be in the data folder for the links to work.

Within the Database folder there should be a folder called “Database_images”. Within this folder should be a folder for the current monitoring year. The year folder will have a folder for each park. Images that are to be linked to the database should be organized into folders by date of sampling event and placed in the appropriate folder for the year and park. All other images should go into the image folder in the main directory.

Flowtracker data that will be linked to the database should be placed in the folder called “Flowtracker_pdfs” (see Figure S.25.2). Within this folder should be a folder for the current monitoring year. Each of the year folders will have a folder for each park. The flowtracker .pdf files should be organized into folders by date of sampling event and placed in the appropriate folder for the year and park. Make sure these files are placed in the correct folders before linking to the database.

Following these steps will ensure that the files will be re-linked to the database upon moving as long as the structure is maintained.

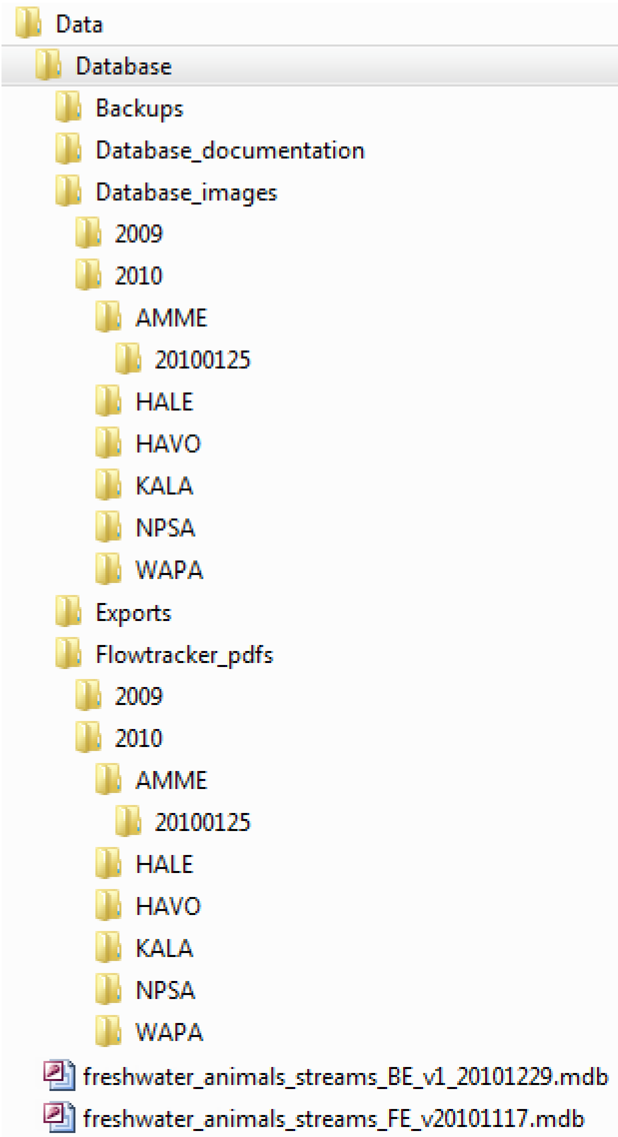

Figure S.25.2. Required file structure for images and flowtracker data linked to the Freshwater Animal Communities, Streams database.

Each major subfolder is described as follows:

1) Analysis – Contains working files associated with data analysis.

2) Data – Contains subfolders to categorize project data and the working database file for the season. The master database for the project is stored in the PACN Digital Library.
3) Documents – Contains subfolders to categorize documents as needed for various stages of project implementation.

4) Images – For storing images associated with the project (refer to SOP #29: "Managing Photographic Images"). Note that this folder contains subfolders to arrange files by year.

5) Spatial info – Contains subfolders that arrange files relating to visualizing and interacting with GIS data by year and layers. Yearly folders are broken down into the following subfolders

   a. ArcMap documents – Map products.
   b. GIS data – New working shapefiles and geodatabases specific to the project.
   c. GPS data – Contains GPS data dictionaries, and raw and processed GPS data files.
   d. File naming conventions for files in this folder are as follows:
      - YYYYMMDD_Park Code_site type_temp (temp stations, plots, etc) Example: **20100121_WAPA_stream_temp.mxd**
      - Park Code_site type_fixed (fixed stations, plots, etc.) Example: **KAHO_marine_fixed.shp**

Naming Conventions

Folder Naming Standards

In all cases, folder names should follow these guidelines:

1) No spaces or special characters in the folder name.

2) Use the underbar ("_") character to separate words in folder names.

3) Try to limit folder names to 20 characters or fewer.

4) Dates should be formatted as YYYYMMDD.

File Naming Standards

In all cases, file names should follow these guidelines:

1) No spaces or special characters in the file name.

2) Use the underbar ("_") character to separate file name components.

3) Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters.

4) Dates should be formatted as YYYYMMDD.

5) Correspondence files should be named as YYYYMMDD_AuthorName_subject.ext.

Archival and records management

All project files should be reviewed, cleaned up, and organized by the Project Lead on a regular basis (e.g., annually in January). Decisions on what to retain and what to destroy should be made following guidelines stipulated in NPS Director's Order 19[7], which provides a schedule indicating the amount of time that the various kinds of records should be retained. Although many of the files for this project may be scheduled for permanent retention, it is important to isolate and protect these important files and not lose them in the midst of a large, disordered array of miscellaneous project files. Because this is a long-term monitoring project, good records management practices are critical for ensuring the continuity of project information. Files will be more useful to others if they are well organized, well named, and stored in a common format. In addition, it is important that files containing sensitive information be stored in a manner that will enable quick identification. Refer to SOP #33: "Sensitive Information Procedures" for more information.

To help ensure safe and organized electronic file management, PACN has implemented a system called the PACN Digital Library, which is a hierarchical digital filing system stored on the PACN file servers. The typical arrangement is by project, then by year to facilitate easy access. Network users have read-only access to these files, except where information sensitivity may preclude general access. Submission of certified products occurs in the PACN Digital Library by uploading the certified products in the "Submissions" folder and notifying the Data Manager.

As digital products are delivered for long-term storage according to the schedule in SOP #30: "Product Delivery Specifications", they will be catalogued in the PACN project tracking database and filed within the PACN Digital Library by the Data Manager. The master versions of all digital files relating to the Freshwater Animals Communities, Streams protocol are stored within the PACN Digital Library, with regular file back-ups accomplished automatically. Presently, the master protocol files include the protocol narrative, the SOPs, and the Freshwater Animal Communities, Streams database files. Analog (non-digital) materials are to be handled according to current practices of the individual park collections.

Archived Data Maintenance

Any editing of archived data is accomplished jointly by the Project Lead or designee and PACN Data Manager. Prior to any major changes of a dataset, a copy is stored with the appropriate version number to allow for tracking of changes over time. Likewise, any time a revision of the protocol requires a revision to the database, a complete copy of the database will be made and stored in an archive directory. In addition to this copy in its native database format, all tables will be archived in a comma-delimited ASCII format that is platform-independent by using the Access_to_ascii.mdb utility developed by Northern Colorado Plateau Network.

Versioning of archived datasets is handled by adding a three digit number to the file name, with the first version being numbered 001 (e.g., freshwater_animal_streams_be_2008_validated_v001, for the first version of a back-end data file

[7] http://www.nps.gov/refdesk/DOrders/DOrder19.html

validated by the Project Lead and Data Manager at the end of the 2008 field season). The two text files generated by the Access_to_ascii.mdb utility, FieldDef.txt and TableDef.txt, will be stored in a similarly named folder (e.g., freshwater_animal_streams_be_2008_validated_v001_text). Each additional version is assigned a sequentially higher number. Frequent users of the data are notified of the updates, and provided with a copy of the most recently archived version.

Every change must be documented in the edit log and accompanied by an explanation that includes pre- and post-edit data descriptions. All data collected using this protocol are subject to the following three caveats:

1) Only make changes that improve or update the data while maintaining data integrity.

2) Once archived, document any changes made to the data set through an edit log. At end of each fiscal year, the database manager will update the central database and will post read-only versions.

3) Mistakes can be made during editing so updates must be compared with the original data form prior to validating the data.

Standard Operation Procedure (SOP) #26:
Data Entry and Verification

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure document describes the general procedures for entry and verification of field data in the working project database. Refer to protocol sections Overview of Database Design and Data Entry and Processing for related guidance and a clarification of the distinction between the working database and the master database.

Data Entry

The following are general guidelines to keep in mind:

1) Data entry will be conducted by the Field Lead at his or her duty station.

2) Data entry should occur as soon after data collection as possible so that field crews keep current with data entry tasks, and catch any errors or problems as close to the time of data collection as possible.

3) The working database application will be found in the project workspace. The project workspace may be on the user's computer if the connection to the networked server is too slow (see SOP #25: "Workspace Setup and Project Records Management"), with periodic uploads to the network server. If the workspace resides on the networked server, it is recommended that users copy the front-end database onto their workstation hard drives and open it there for enhanced performance. This front-end copy may be considered "disposable" because it does not contain any data, but rather acts as an interface with data residing in the back-end working database.

4) Each data entry form is patterned after the layout of the field form, and has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged only to use the pre-built forms as a way of ensuring the maximum level of quality assurance.

5) As data are being entered, the person entering the data should visually review each data form to make sure that the data on-screen match the field forms. This should be done for each record prior to moving to the next form for data entry.

6) After each data entry session, the Field Lead should upload the working copy of the database onto the networked server if the database has been stored on their computer.

Data Verification

Data verification checks that the digitized data match the source data. The following guidelines regarding data verification should be followed:

1. Project leaders are responsible for specifying in the project protocol one or more of the data verification methods available and ensuring proper execution. At the discretion of the project leader, additional verification methods may be applied.
2. Data verification is carried out by staff thoroughly familiar with data collection and entry.
3. All records (100%) should be verified against original source data using the method below.
    a) Visual review after data entry: Upon completion of data entry, all records are printed and compared with the original values from the hard copy. Errors are clearly marked and corrected in the database as soon after data entry as possible. Reliability increases if someone other than the person keying the data performs the review. Alternatively, two technicians (one reading from the original data and one checking the entered data) can perform this review.
4. A subset of randomly selected records (10%) should be reviewed after initial verification by the project leader. If errors are found, the entire data set should be verified again.
5. A record of the verification process for each data set, including number of iterations and results, will be prepared by the project leader as part of formal metadata generation.
6. Spatial data collected as part of the project will be viewed in a GIS and visually inspected for accuracy (e.g., points located outside park boundaries, upland locations occurring in water).

Database Instructions

The first action to take is to make sure the data entry workspace is set up properly, either on a networked drive or the user's computer (if networked server connections are too slow for efficient data entry). If you are unclear about where the data entry workspace should be, contact the Data Manager (see SOP #25: "Workspace Setup and Project Records Management" for more information).

1) Store the back-end database file in the database folder in the project workspace. The back-end file has "_be_" as part of its name.

2) The user's copy of the front-end database should also be stored in the same folder.

3) If it doesn't already exist, also create a folder in the same folder named "backups" for storing daily backups of the back-end database file.

4) Open the front-end database. The first thing it will do is to ask to update the links to the back-end database file. This will only need to be done once for each new issue of the front-end database.

Important Reminders for Daily Database Use

1) A copy of the front-end will need to be copied to your workstation if the project workspace is set up on the networked server. <u>Do not open up and use the front-end on the network</u> as this 'bloats' the database file and makes it run more slowly.

2) The front-end application will automatically prompt you to make a backup upon initially opening the application.

3) To save drive space and network resources, backup files should be compacted by right-clicking on the backup file in Windows Explorer and selecting the option: "Add to Zip file". Older files may be deleted at the discretion of the Field Lead.

4) New issues of the front-end application may be released as needed through the course of the field season. If this happens, there should be no need to move or alter the back-end file. Instead, the front-end file may be deleted and replaced with the new version, which will be named in a manner reflecting the update (e.g., freshwater_animal_streams_be_2008_v2.mdb).

5) If the front-end database gets bigger and slower, compact it periodically by selecting Tools > Database Utilities > Compact and Repair Database.

Working Database Functions

The working front-end application has the following functional components, which are accessed from the main application switchboard form that opens automatically when the application starts:

Data Entry and Review

1) Data entry/edit: After verifying default settings (e.g., park, coordinate datum) the data gateway form will open. From here, data for a particular sampling date and location can be reviewed and edited if necessary. By choosing the option "Add a New Record" the data entry form will open and new data may be entered.

2) Quality assurance tools: opens a form that shows the results of pre-built queries that check for data integrity, missing data, and illogical values, and allows the user to fix these problems and document the fixes. See SOP #27: "Post-season Data Quality Review and Certification."

Other Functions

1) Manage lookups: opens a tool for managing the lookup values for the project data set (e.g., species list, list of project personnel)

2) View database window: allows the user to view the database objects (tables, queries and forms)

3) Back up data: creates a date-stamped copy of the back-end database file

4) Connect back-end database: Verifies the connection to the back-end working database file, and provides the option to redirect or update that connection

5) Set system defaults: for example, user name, declination, current park, coordinate datum

6) View release history: opens a form describing known bugs and changes made to the front-end database since its first release

General Use Instructions

To view detailed instructions for entering and editing data, see Appendix X: Freshwater Animal Communities, Streams Monitoring Database User's Guide.

Standard Operation Procedure (SOP) #27:
Post-season Data Quality Review and Certification

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure document describes the procedures for validation and certification of data in the working project database. Refer also to protocol sections in Chapter 4 (Overview of Database Design, Quality Review, and Data Certification and Delivery) for related guidance and a clarification of the distinction between the working database and the master database.

After the season's field data have been entered and processed, they need to be reviewed and certified by the Project Lead for quality, completeness and logical consistency. Data validation is the process of checking data for completeness, logical consistency, and structural integrity. The working database application facilitates this process by showing the results of pre-built queries that check for data integrity, data outliers and missing values, and illogical values. The user may then fix these problems and document the fixes.

Data Quality Review

At the end of each field season, the Project Lead and the PACN data management staff are collectively responsible for finalizing a validated dataset for that field season. The Project Lead will complete all data validation. Some validation (ensuring that the data make sense) methods have been incorporated into the Stream Macrofauna database. Other, more specific validation routines will be worked out with the Project Lead and/or project staff and incorporated into the database as appropriate. These modifications will be described in the edit log and the functionality of the validation routines will be explained in detail in the Stream Macrofauna Database User Guide.

Completing Data Certification

Data certification is a benchmark in the project information management process that indicates: 1) the data are complete for the period of record, 2) the data have undergone and passed the quality assurance checks, and 3) that the data are appropriately documented and in a condition for archiving, posting and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies which may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. Once the data have been through the validation process and metadata have been developed for them, they are to be certified by completing the PACN Project Data Certification Form[8], available on the PACN website. The Project Lead is primarily responsible for completing this form. The completed form, certified data, and updated metadata may then be delivered to the Data Manager according to the timeline in Appendix #12: "Yearly Project Task List". Refer to SOP #30: "Product Delivery Specifications" for delivery instructions.

[8] http://www1.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Project_Data_Certification_Form.doc

Standard Operation Procedure (SOP) #28:
Field Form Handling Procedures

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes how to process field data forms.

Field form handling procedures

As the field data forms are part of the permanent record for project data, they should be handled in a way that preserves their future interpretability and information content. If changes to data on the forms need to be made either during or after field data acquisition, the original values should not be erased or otherwise rendered illegible. Instead, changes should be made as follows:

1) Draw a horizontal line through the original value, and write the new value adjacent to the original value with the date and initials of the person making the change.

2) All corrections should be accompanied by a written explanation in the appropriate notes section on the field form. These notes should also be dated and initialed.

3) If possible, edits and revisions should be made in a different color ink to make it easier for subsequent viewers to be able to retrace the edit history.

4) Edits should be made on the original field forms and on any photocopied forms.

These procedures should be followed throughout data entry and data revision. After each tour, data sheets are to be scanned as PDF documents and placed in the project workspace folder assigned to data forms (see SOP #25: “Workspace Setup and Project Records Management” for more details). These digital files will be archived with the certified data according to SOP #30: “Product Delivery Specifications”. The PDF files may then serve as a convenient digital reference of the original if needed.

Standard Operation Procedure (SOP) #29:
Managing Photographic Images

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure document describes how to process photographic images collected by project staff or volunteers during the course of conducting project-related activities. Images that are acquired by other means – e.g., downloaded from a website or those taken by a cooperating researcher – are not project records and should be handled separately.

Care should be taken to distinguish data photos from incidental or opportunistic photos taken by project staff. Data photos are those taken for at least one of the following reasons:

1) to document a particular feature or perspective for the purpose of site relocation

2) to capture site habitat characteristics and possibly to indicate gross structural changes over time

3) to document a species detection that is also recorded in the data

Data photos are linked to specific records within the database, and are stored in a manner that permits the preservation of those database links. Other photos—e.g., of field crew members at work, or photos showing fish, shrimp, or snails—may also be retained but are not necessarily linked with database records.

Effectively managing hundreds of photographic images requires a consistent method for downloading, naming, editing, and documenting. The general process for managing data photos proceeds as follows:

1) File Structure Setup – Set up the file organization for images prior to acquisition

2) Image Acquisition

3) Download and Process
    a. Download the files from the camera
    b. Rename the image files according to convention
    c. Copy and store the original, unedited versions
    d. Review and edit or delete the photos
    e. Move into appropriate folders for storage

4) Establish Database Links

5) Deliver Image Files for Final Storage

File Structure Setup

Prior to data collection for any given year, project staff will need to set up a new folder under the Images folder in the project workspace as follows:

[Year]	The appropriate year – 2008, 2009, etc.
_Processing	Processing workspace
_Ricoh_memos	Memos to be loaded onto the Ricoh GPS camera
[Park code]	Arrange files by park – HAVO, NPSA, etc.
[Park code]	Arrange files by park – HAVO, NPSA, etc.
Data	Data images
[Site_code]	Arranged by sampling locations, or
[Date]	by date, for images not taken at sampling locations
Miscellaneous	Non-data images taken by project staff
[Site_code]	Arranged by sampling locations, or
[Date]	by date, for images not taken at sampling locations
Originals	Renamed but otherwise unedited image file copies
[Site_code]	Arranged by sampling locations, or
[Date]	by date, for images not taken at sampling locations
Ricoh_Camera	Arranged by sampling locations and date

This folder structure permits data images to be stored and managed separately from non-record and miscellaneous images collected during the course of the project. It also provides separate space for image processing and storage of originals. Note: For additional information about the project workspace, refer to SOP #25: “Workspace Setup and Project Records Management.”

Folder Naming Standards

In all cases, folder names should follow these guidelines:

1) No spaces or special characters in the folder name

2) Use the underscore (“_”) character to separate words in folder names

3) Try to limit folder names to 20 characters or fewer

4) Dates within folder names should be formatted as YYYYMMDD (for better sorting)

Image Acquisition

Capture images at an appropriate resolution that balances space limitations with the intended use of the images. Although photographs taken to facilitate future navigation to the site do not need to be stored at the same resolution as those that may be used to indicate gross environmental change at the site, it may be more efficient to capture all images at the same resolution initially. A recommended minimum raw resolution is 1600 x 1200 pixels (approximately 2 megapixels).

Download and Processing Procedures

1) Download the raw, unedited images from the camera into the appropriate "_Processing" folder.
2) Rename the images according to convention (refer to the image file naming standards section below). If image filenames were noted on the field data forms, be sure to update these to reflect the new image filename prior to data entry. See SOP #28: "Field Form Handling Procedures."
3) Process the images in the "_Processing" folder. At a minimum, the following processing steps should be performed on all image files:
    a. Copy the images to the "Originals" folder and set the contents as read-only by right clicking in Windows Explorer and checking the appropriate box. These originals are the image backup to be referred to in case of unintended file alteration or deletion.
    b. Delete any poor-quality photos, repeats, blurred or otherwise unnecessary photos. Low-quality photos might be retained if the subject is highly unique, or the photo is an irreplaceable data photo.
    c. Rotate the image to make the horizon level.
    d. Photos of people should have red eye glare removed.
    e. Photos should be cropped to remove edge areas that grossly distract from the subject.
4) When finished, move the image files that are to be retained and possibly linked in the database to the appropriate folder – data images under the Data folder, other images under the Miscellaneous folder. Photos of interest to a greater audience should be copied to the PACN Digital Library\Photo Archive folder. Metadata associated with the image should be entered into the ThumbsPlus application. To minimize the chance for accidental deletion or overwriting of needed files, no stray files should remain in the processing folder between downloads.
5) Depending on the size of the files and storage limitations, contents of the Originals folder may be deleted if all desired files are accounted for after processing.

Large groups of photos acquired under suboptimal exposure or lighting can be batch processed to enhance contrast or brightness. Batch processing can also be used to resize groups of photos for use on the web. Batch processing may be done in ThumbsPlus, Extensis Portfolio or a similar image software package.

Image File Naming Standards

In all cases, image names should follow these guidelines:

1) No spaces or special characters in the filename

2) Use the underscore ("_") character to separate file name components

3) Try to limit filenames to 30 characters or fewer, up to a maximum of 50 characters

4) Park code and year should either be included in the filename or conclusive by the directory structure

The image file name should consist of the following parts:

1) The date of data capture (formatted as YYYYMMDD)

2) The sampling location (if recorded at a sampling location)

3) Optional: a brief descriptive word or phrase

4) Optional: a sequential number if multiple images were captured

5) Optional: time (formatted as HHMM)

Examples:

1) 20070621_Waihanau_habitat_001.jpg: The habitat at Waihanau Valley taken on June 21, 2007

2) 20070518_training_004.jpg 4th photo taken during training on May 18, 2007

In cases where there are few photos it is practical to individually rename these files. However, for larger numbers it may be useful to rename files in batches. This may be done in ThumbsPlus, Extensis Portfolio or a similar image software package. A somewhat less sophisticated alternative is to batch rename files in Windows Explorer, by first selecting the files to be renamed and then selecting File > Rename. The edits made to one file will be made to all others, although with the unpleasant side effect of often adding spaces and special characters (e.g., parentheses) which will then need to be removed manually.

Renaming photos may be most efficient as a two-part event—one step performed as a batch process which inserts the date and transect number at the beginning of the photo name, and a second step in which a descriptive component is manually added to each filename.

Establish Database Links

During data entry and processing, the database application will provide the functionality required to establish a link between each database record and the appropriate image file(s). To establish the link, the database prompts the user to indicate the root project workspace directory path, the specific image folder within the project workspace, and the specific file name. This way, the entire workspace may be later moved to a different directory (i.e., the PACN Digital Library) and the links will still be valid after changing only the root path. Refer to SOP #25: "Workspace Setup and Project Records Management" and SOP #26: "Data Entry and Verification" for additional details on setting up the database images structure and establishing these links.

Note: It is important that the files keep the same name and relative organization once these database links have been established. Users should not rename or reorganize the directory structure for linked image files without first consulting with the Data Manager.

Deliver Image Files for Final Storage

Please refer to SOP #30: "Product Delivery Specifications."

At the end of the season, and once the year's data are certified, data images for the year may be delivered along with the working copy of the database to the Data Manager on an external drive.To do this, simply copy the folder for the appropriate year(s) and all associated subfolders and images onto the disk. These files will be loaded into the project section of the PACN Digital Library, and the database links to data images will be updated accordingly.

Prior to delivery, make sure that all processing folders are empty. Upon delivery, the delivered folders should be made read-only to prevent unintended changes.

Standard Operation Procedure (SOP) #30:
Product Delivery Specifications

Version 1.01

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure document provides details on the process of submitting completed data sets, reports, and other project deliverables. Prior to submitting digital products, files should be named according to the naming conventions appropriate to each product type (see below for general naming conventions).

All digital file submissions that are sent by email should be accompanied by a Product Submission Form[9], which briefly captures the following information about the products:

1) Submission date

2) Name of the person submitting the product(s)

3) Name and file format of each product

4) Indication of whether or not each product contains sensitive information (see SOP #33: "Sensitive Information Procedures" for more detail).

The Product Submission Form[10] can be obtained from the Data Manager or from the PACN website. Upon notification and/or receipt of the completed products, the Data Manager or GIS Specialist will check them into the PACN project tracking application.

[9] http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Product_Submissions_Form.doc
[10] http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Product_Submissions_Form.doc

Table S.30.1. Product delivery schedule and specifications.

Deliverable Product	Primary Responsibility	Target Date	Instructions
Field season report	Project Lead	September 15 of the same year	Upload digital file in MS Word format to the PACN Digital Library [1] submissions folder.
Raw GPS data files	Field Lead	September 15 of the same year	Zip and send all digital files to the GIS Specialist who will post them to the PACN Digital Library[1].
Processed GPS data files	GIS Specialist	September 15 of the same year	Zip and upload files to the PACN Digital Library[1].
Digital photographs	Project Lead	November 30 of the same year	Organize, name and maintain photographic images in the project workspace according to SOP #29: "Managing Photographic Images."
Certified working database	Project Lead	November 30 of the same year	Refer to the following section on delivering certified data and related materials. Data will be uploaded to the IRMA Portal[2], and stored in the PACN Digital Library[1].
Certified geospatial data	Project Lead with GIS Specialist		
Data certification report	Project Lead		
Metadata interview form	Project Lead		
Full metadata (parsed XML)	Data Manager and GIS Specialist	March 15 of the following year	Upload the parsed XML record to the IRMA Portal[2], and store in the PACN Digital Library[1].
Annual I&M report	Project Lead	April 30 of the following year	Refer to the following section on reports and publications. Final reports will be entered in IRMA Portal[2], and stored in the PACN Digital Library[1].
5-year analysis report	Project Lead, Data Analyst	Every 5 years by April 30	
Other publications	Project Lead, Data Analyst	as completed	
Field data forms	Project Lead	Every 5 years by April 30	Scan original, marked-up field forms as PDF files and upload these to the PACN Digital Library [1] submissions folder. Originals go to the park curator for archival.
Other records	Project Lead	review for retention every January	Organize and send analog files to park curator for archival. Digital files that are slated for permanent retention should be uploaded to the PACN Digital Library. Retain or dispose of records following NPS Director's Order #19 [3].

[1] The PACN Digital Library is a hierarchical digital filing system stored on the PACN file servers. Network users have read-only access to these files, except where information sensitivity may preclude general access.
[2]The IRMA Portal is a clearinghouse for natural resource data, metadata, bibliographic records, and park species information (http://irma.nps.gov/App/Portal/Home). Only non-sensitive information is posted to the IRMA Portal. Refer to the protocol section on sensitive information for details.
3 NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: http://data2.itc.nps.gov/npspolicy/DOrders.cfm

Specific Instructions for Delivering Certified Data and Related Materials

Data certification is a benchmark in the project information management process that indicates that: 1) the data are complete for the period of record; 2) they have undergone and passed the quality assurance checks; and 3) that they are appropriately documented and in a condition for archiving, posting and distribution as appropriate. To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. For more information refer to SOP #27: “Post-Season Data Quality Review and Certification.”

The following deliverables should be delivered as a package:

1) *Certified working database* – Database in MS Access format containing data for the current season that has been through the quality assurance checks documented in SOP #27: “Post-Season Data Quality Review and Certification.”

2) *Certified geospatial data* – GIS themes in ESRI coverage or shapefile format.

3) *Data certification form* – A brief questionnaire in MS Word that describes the certified data product(s) being submitted. A template form is available on the PACN website (http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Project_Data_Certification_Form.doc).

4) *Metadata interview form* – The metadata interview form is an MS Word questionnaire that greatly facilitates metadata creation. This form is available on the PACN website (http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Metadata_Interview_Form.doc). For more details, refer to SOP #31: “Metadata Development.”

After the quality review is completed, the Project Lead should package the certification materials for delivery as follows:

1) Open the certified back-end database file and compact it (in Microsoft Access, Tools > Database Utilities > Compact and Repair Database). This will make the file size much smaller. Back-end files are typically indicated with the letters “_be” in the name (e.g., stream_macrofauna_be_2007.mdb).

2) Rename the certified back-end file with the project name (“stream_macrofauna”), the year or span of years for the data being certified, and the word “certified”. For example: stream_macrofauna_2007_certified.mdb.

3) Create a compressed file (using WinZip or similar software) and add the back-end database file to that file. Note: The front-end application does not contain project data and as such should not be included in the delivery file.

4) Add the completed metadata interview and data certification forms to the compressed file. Both files should be named in a manner consistent with the naming conventions described elsewhere in this document.

5) Add any geospatial data files that aren’t already in the possession of the GIS Specialist. Geospatial data files should be developed and named according to PACN GIS Naming Conventions.

6) Upload the compressed file containing all certification materials to the submissions folder of the PACN Digital Library. If the Project Lead does not have access to the PACN Digital Library, then certification materials should be delivered as follows:
    a. If the compressed file is less than 5 megabytes in size, it may be delivered directly to the Data Manager by email.
    b. If the compressed file is larger than 5 megabytes, it should be copied to an external drive and delivered in this manner.

7) Notify the Data Manager by email that the certification materials have been uploaded or otherwise sent.

Upon receiving the certification materials, the Data Manager will:

1) Review them for completeness and work with the Project Lead if there are any questions.

2) Notify the GIS Specialist if any geospatial data are submitted. The GIS Specialist will then review the data, and update any project GIS data sets and metadata accordingly.

3) Check in the delivered products using the PACN project tracking application.

4) Store the certified products together in the PACN Digital Library.

5) Upload the certified data to the master project database.

6) Notify the Project Lead that the year's data have been uploaded and processed successfully. The Project Lead may then proceed with data summarization, analysis and reporting.

7) Develop, parse and post the XML metadata record to the NPS Data Store.

8) After a holding period of 2 years, the Data Manager will upload the certified data to the NPS Data Store. This holding period is to protect professional authorship priority and to provide sufficient time to catch any undetected quality assurance problems. See SOP #34: "Product Posting and Distribution."

Specific Instructions for Reports and Publications

Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Annual reports will use the Natural Resource Report[11] template, and trend analysis and other peer-reviewed technical reports will use the Natural Resource Technical Report[12] template. Instructions for acquiring a series number and other information about NPS publication

[11] http://www.nature.nps.gov/publications/nrpm/docs/templates/NRR_Template_v3.dot
[12] http://www.nature.nps.gov/publications/nrpm/docs/templates/NRTR_Template_v3.dot

standards can be found at the NPS Natural Resources Publications website[13]. In general, the procedures for reports and publications are as follows:

1) The document should be formatted using the NPS Natural Resource Publications template. Formatting according to NPS standards is easiest when using the template from the very beginning, as opposed to reformatting an existing document.

2) The document should be peer reviewed at the appropriate level. For example, I&M Annual Reports should be reviewed by other members of the appropriate project work group. The Program Manager will also review all annual reports for completeness and compliance with I&M standards and expectations.

3) Upon completing the peer review, acquire a publication series number from the NPS Peer Review Manager (currently the Regional I&M Program Manager).

4) Upload the file in PDF and MS Word formats to the PACN Digital Library submissions folder.

5) Send a printout to each park curator.

6) The Data Manager or a designee will create a bibliographic record and upload the PDF document to NRInfo according to document sensitivity.

File naming conventions

In all cases, digital file names should follow these guidelines:

1) No spaces or special characters in the filename

2) Use the underscore ("_") character to separate filename components

3) Try to limit filenames to 30 characters or fewer, up to a maximum of 50 characters

4) As appropriate, include the project name (e.g., "stream_macrofauna"), network code ("PACN") or park code, and year in the filename.

Examples:

1) PACN_stream_macrofauna_2008_Annual_report.pdf
2) PACN_stream_macrofauna_2008_Field_season_report.doc

[13] http://www.nature.nps.gov/publications/NRPM/index.cfm

Standard Operating Procedure (SOP) #31:
Metadata Development

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose
This Standard Operating Procedure document describes the guidelines for documenting data and how it should be accomplished.

Metadata Documentation
Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition and other characteristics of a given data set. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all PACN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed and synthesized.

Updated metadata is a required deliverable that should accompany each season's certified data. For long-term projects such as this one, metadata creation is most time consuming the first time it is developed – after which most information remains static from one year to the next. Metadata records in subsequent years then only need to be updated to reflect changes in contact information and taxonomic conventions, to include recent publications, to update data disposition and quality descriptions, and to describe any changes in collection methods, analysis approaches or quality assurance for the project.

Specific procedures for creating, parsing, and posting the metadata record are found in PACN Metadata Development Guidelines[14]. The general flow is as follows:

1. After the annual data quality review has been performed and the data are ready for certification, the Project Lead (or a designee) updates the PACN Metadata Interview Form[15].
    a. The metadata interview form greatly facilitates metadata creation by structuring the required information into a logical arrangement of 15 main questions, many with additional sub-questions.
    b. The first year, a new copy of the metadata interview form should be downloaded. Otherwise the form from the previous year can be used as a starting point, in which case the Track Changes tool in MS Word should be activated in order to make edits obvious to the person who will be updating the XML record.
    c. Complete the metadata interview form and maintain it in the project workspace. Much of the interview form can be filled out by cutting and pasting material from other documents (e.g., reports, protocol narrative sections, and SOPs).
    d. The Data Manager can help answer questions about the metadata interview form.

2. Deliver the completed interview form to the Data Manager according to SOP #30: Product Delivery Specifications."

3. The Data Manager (or GIS Specialist for spatial data) will then extract the information from the interview form and use it to create and update an FGDC- and NPS-compliant metadata record in XML format. Specific guidance for creating the XML record is contained in PACN Metadata Development Guidelines.

4. The Data Manager will post the record and the certified data to the IRMA Portal[3], and maintain a local copy of the XML file for subsequent updates

5. The Project Lead should update the metadata interview content as changes to the protocol are made, and each year as additional data are accumulated.

Identifying sensitive information

Part of metadata development includes determining whether or not the data include any sensitive information, which is partly defined as the specific locations of rare, threatened or endangered species. Prior to completing the metadata interview form, the Project Lead should identify any sensitive information in the data after first consulting SOP #33: "Sensitive Information Procedures." Findings may be documented and communicated to the Data Manager through the metadata interview form.

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[14] http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Metadata_Guidelines.pdf
[15] http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Metadata_Interview_Form.doc

Standard Operating Procedure (SOP) #32:
Data Analysis and Reporting

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure describes methods for data analysis and reporting of stream macrofauna and habitat surveys. Data analyses for the abundance and size of fish, shrimp, and snails, as well as geomorphologic habitat characteristics, are outlined with examples to show data structure, statistical tests, and graphical plots. This SOP outlines two initial steps of data analysis at each of the station, stream, and trend assessment levels. These steps summarize and determine the range-of-variation for some parameters. A third step which integrates habitat characteristics with biological data is also included at the trend assessment level. Report types are identified according to the categories in the PACN monitoring plan, with most reporting occurring on an annual basis. Specifically, station level and stream level size, abundance, and habitat characteristic summarization and range of variation data is reported on an annual basis.
Statistical trend analyses are conducted on abundance data on an annual basis (after five years of data have been collected). Trend analysis of size and habitat data, as well as integration of biological data with habitat characteristics, is included in the five year reports. Additional, multi-vital sign integration, synthesis, analysis, and reporting is not addressed in this SOP at present. The use of products identified in this protocol does not imply endorsement, effectiveness, or warranty by NPS.

A master equipment list for the entire Pacific Islands Stream Monitoring Protocol can be found in Table S.2.1 of SOP #2: “Preparation for the Field Sampling.” The master equipment list should be updated simultaneously if any SOP requiring an equipment list is revised.

Analysis Overview

Data analysis is defined here as the steps by which observations of the environment are processed for interpretation and synthesis into meaningful information that is accessible to managers. Data analysis also includes quality assurance and control efforts that occur in the field, during exploratory analysis, in summarization, during interpretation, and when drawing conclusions.

Analytical Approach

Two basic initial steps are identified in data analysis for all Pacific Islands Stream monitoring data: summarization and establishing the range of variation. These steps are encompassed in the larger construct of data management and data stewardship which is discussed in SOPs #25-31. We identify four basic levels of analytical methods for our monitoring data: station level, stream level, trend assessment level, and synthesis (Table S.32.1). Quadrant (Hawaii and American Samoa) or segment (Guam) level macrofauna abundance and size data is used to calculate summarization and range of variation data (mean and standard deviation) for each station. Similarly, transect data is used to calculate summarization and range of variation data for habitat characteristics (e.g. velocity, substrate characteristics, etc.). The station level data includes mean and standard deviation abundance, size, and habitat characteristic data at a given station over time. The stream level data includes mean and standard deviation abundance, size, and habitat characteristic data at all stations in a stream at a given time. The trend assessment level integrates station or stream level abundance, size, and habitat characteristic summarization and range of variation data over time to detect change. For example, some form of regression may be used to identify the slope or trend. In addition, a third step is included in the trend assessment level that uses multivariate statistics to integrate station and stream level macrofauna abundance and size data with habitat characteristics. Finally, synthesis examines relationships between temporal and spatial trends in stream macrofauna size and abundance and water quality data. Station level, stream level, and trend assessment level are addressed here. Synthesis will be addressed within and across multiple Vital Signs and is therefore left for network level or broader scientific consideration in the future.

Table S.32.1. Three approaches for analyzing Pacific Islands Stream Vital Sign monitoring data.

Analysis	Description	Responsible Party
Station Level	Quality assurance and control routines and calculation of statistics from monitoring data (abundance, size, habitat): Step 1 (Summarization): Measures of mean, median, variation, and other basic statistics. Include graphical presentation of data. Step 2 (Range of Variation): Establish historical or expected range of values, relation to relevant regulatory levels, confidence estimates.	Biological technician with oversight by aquatic ecologist and with assistance from park leads
Stream Level	Quality assurance and control routines and calculation of statistics from monitoring data (abundance, size, habitat): Step 1 (Summarization): Measures of mean, median, variation, and other basic statistics. Include graphical presentation of data. Step 2 (Range of Variation): Establish historical or expected range of values, relation to relevant regulatory levels, confidence estimates.	Biological technician with oversight by aquatic ecologist and with assistance from park leads
Trend Assessment	Step 1: Integration of station and stream level summarization over time using some form of regression analysis. Step 2: Integration of station and stream level variation results over time using some form of regression analysis. Includes establishing a direction and rate of change of variation that may be used to provide early warnings of trends in resources condition. Confidence levels of documenting trend will be established. Step 3: Integration of station and stream level abundance and size data with habitat characteristics using a multivariate approach.	PACN aquatic ecologist and researchers from other institutions (e.g. USGS)

These analytical approaches will be applied to each of the components of Vital Signs (e.g. size and abundance of fish, shrimp, and snails and habitat characteristics).

Analysis Procedures

Analysis procedures are to be documented, for each stream on an annual basis as well as on a five year basis, in a compiled document (such as an MS Word® file), referred to hereafter as an analysis log file. This file would essentially be a 'log' of all the quantitative and qualitative steps taken, such as various transformations tested, and screen shots of data visualizations. A check list for the steps is provided in Appendix #14: "Analysis log file checklist." Each year, seven such files (one for each stream that is slated for initial implementation of the Pacific Islands Stream monitoring protocol) will be generated. On Tutuila (American Samoa) it is possible that additional streams will be selected for the yearly random sampling. These analysis log files are internal working documents, that while not subject to explicit peer-review for most reporting other than protocol and programmatic reviews, will serve as the documentation and foundation for analyses for reports which are peer-reviewed. Table S.32.2 summarizes these analytical procedures and frequency of analysis (annually or every five years) for the parameters measured in each stream.

Table S.32.2. Summary of analytical procedures including parameters measured at the stream level.

Level of Analysis	Data Analysis Approach	Frequency of Analysis	Responsible Party
Station	Summarization and range-of-variation for annual macrofauna size, abundance, and habitat characteristics at a given station over time	Annually	Aquatic ecologist
Stream	Summarization and range-of-variation for annual macrofauna size, abundance, and habitat characteristics at a given time over stream longitudinal distribution.	Annually	Aquatic ecologist
Trend Assessment	Multi-year change in macrofauna abundance for both station and stream level data.	Annually (after five years of data have been collected)	Aquatic ecologist and researchers from other institutions (e.g. USGS)
	Multi-year change in macrofauna size and habitat characteristics for both station and stream level data.	Every five years	Aquatic ecologist and researchers from other institutions (e.g. USGS)
	Integration of station and stream level abundance and size data with habitat characteristics using a multivariate approach.	Every five years	PACN aquatic ecologist and researchers from other institutions (e.g. USGS)

Station and Stream Level Analyses: These analyses are conducted annually for macrofauna size, abundance, and habitat characteristic summarization and range of variation data. The data sets are analyzed for normality of the distribution. Text and graphic plots of mean and standard deviation at each station over time (station level analysis) and at each time over stream longitudinal distribution (stream level analysis) are created. If multiple observers have been collecting data, the summaries should be grouped by observer to evaluate potential observer bias.

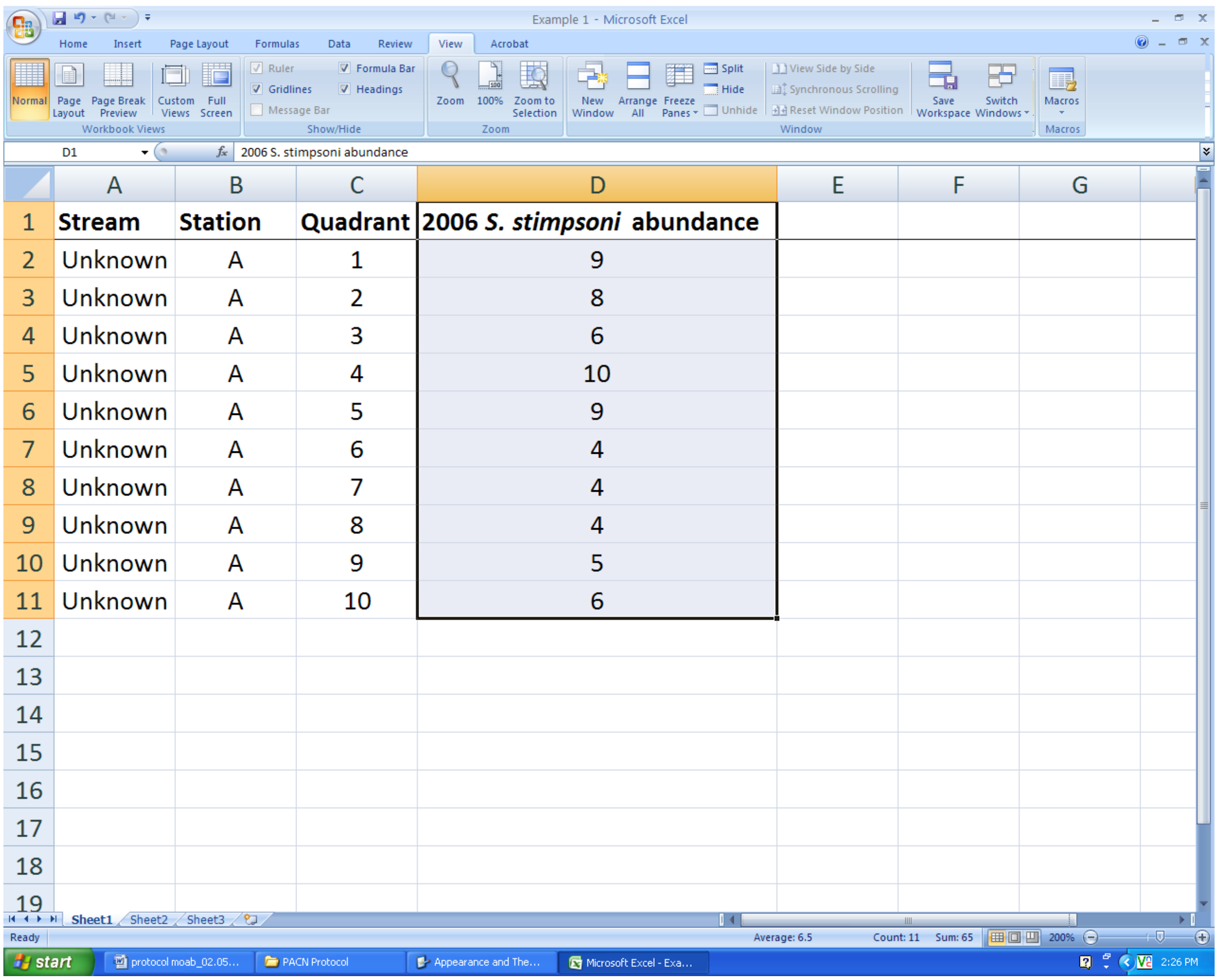
Trend Assessment Analyses: These analyses are conducted annually for macrofauna abundance data after the first five years of data have been collected. These analyses are conducted on a five year recurrence interval for macrofauna size data and habitat characteristic data. However, if an unusual change in abundance is detected, trend analyses for size and habitat characterization should be conducted annually. Text and graphic plots of mean and standard deviation of abundance, size, or habitat characteristics at each station over time (station level analysis) and at each time over stream longitudinal distribution (stream level analysis) are created. Change detection over time can be analyzed using a variety of statistical techniques, including repeated measures ANOVA or regression. Integration of stream and station level abundance and size data with habitat characteristics will be accomplished every five years using canonical correspondence analysis (CCA).

Example Procedure for Stream Macrofauna Abundance

It should be noted that the following analytical procedures should only be conducted by an individual with advanced statistical training. In addition, many of the procedures described below may change over time due to advancements and updates in statistical tests, perspectives, techniques and software. Consequently, this example merely serves to illustrate the desirable sequence of steps necessary to examine and present the data. The data presented in these sections is used for example purposes only and should not be used as part of actual data analysis activities.

Example #1: Checking for normality of the distribution.

Step 1: Copy annual quadrant (or segment in Guam) data for a station from a Microsoft Access® query into Microsoft Excel®. Keep in mind that data copied from Access® is treated as text and must usually be converted into value format. Programs like Excel® can do the value conversion. In this example, abundance of *Sicyopterus stimpsoni* in Unknown Stream from ten quadrants at Station A in 2006 is pasted into the Example 1.xls file (Figure S.32.1).



Stream	Station	Quadrant	2006 *S. stimpsoni* abundance
Unknown	A	1	9
Unknown	A	2	8
Unknown	A	3	6
Unknown	A	4	10
Unknown	A	5	9
Unknown	A	6	4
Unknown	A	7	4
Unknown	A	8	4
Unknown	A	9	5
Unknown	A	10	6

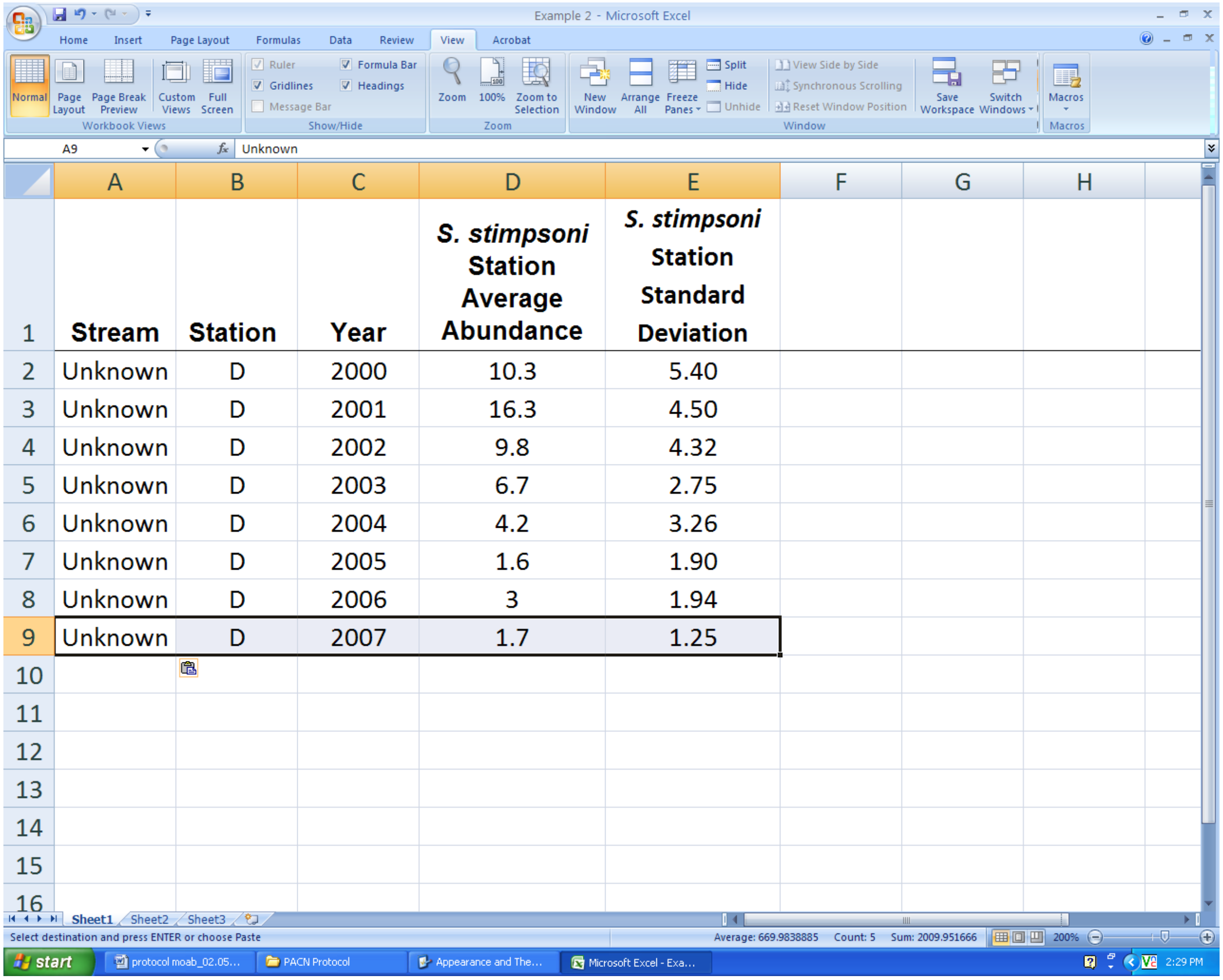
Figure S.32.1. Abundance data structure at the station level in Microsoft Excel®.

Step 2: Check the normality of the distribution of the abundance data by selecting “Data Analysis” under the “Data” tab. Choose “Descriptive Statistics” and define the abundance data as the input range. Select a blank cell as the output range and check the “Summary statistics” box. If the absolute value of the skewness statistic is greater than two standard errors of skewness you can assume that the distribution is significantly skewed (non-normal). The standard error of skewness can be estimated as $\sqrt{\frac{6}{N}}$ (Tabachnick and Fidell, 1996). In this example, the absolute value of skewness is 0.3, which is less than the standard error of skewness (0.77). Therefore, the data can be considered normally distributed.

Step 3: Repeat this procedure for each species in each segment in each stream for the macrofauna abundance and size data as well as the habitat characteristics data each year.

Example #2: Station level analysis of fish abundance data.
Step 1: Copy annual quadrant (or segment in Guam) data for a station from a Microsoft Access® query into Microsoft Excel®.

Step 2: Using quadrant (or segment in Guam) data calculate the average abundance and standard deviation in a segment on a given date for each species. In this example, the 2007 annual average abundance and standard deviation data of *S. stimpsoni* for Unknown Stream at Station D in Unknown Stream is pasted into the Example 2.xls file which already contains data from 2000-2006 (Figure S.32.2).



Stream	Station	Year	*S. stimpsoni* Station Average Abundance	*S. stimpsoni* Station Standard Deviation
Unknown	D	2000	10.3	5.40
Unknown	D	2001	16.3	4.50
Unknown	D	2002	9.8	4.32
Unknown	D	2003	6.7	2.75
Unknown	D	2004	4.2	3.26
Unknown	D	2005	1.6	1.90
Unknown	D	2006	3	1.94
Unknown	D	2007	1.7	1.25

Figure S.32.2. Average abundance and standard deviation data structure at the station level in Microsoft Excel®.

Step 3: Create a plot that shows the change in average station abundance and standard deviation over time (Figure S.32.3). This plot represents station level summarization and range of variation data for *S. stimpsoni* at Station D in Unknown Stream.

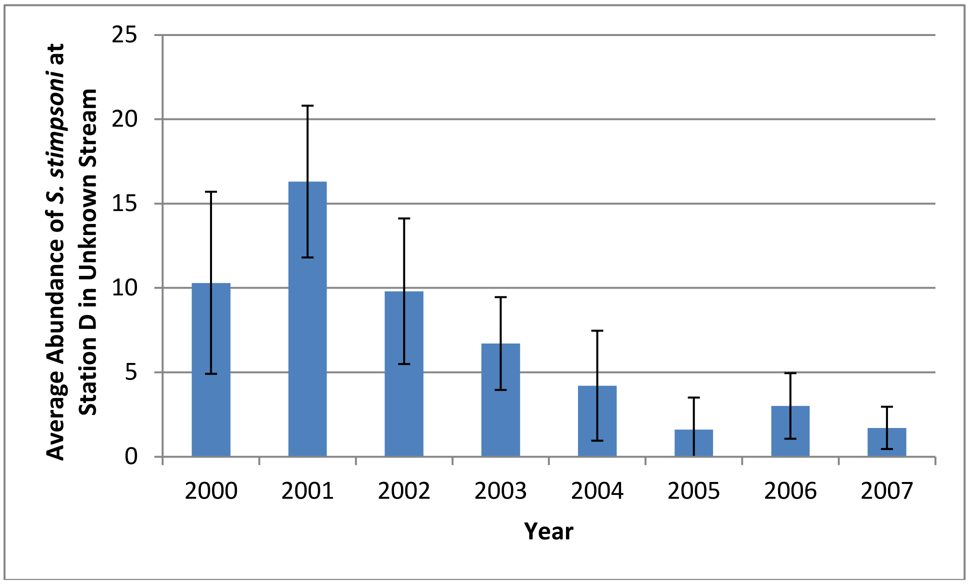
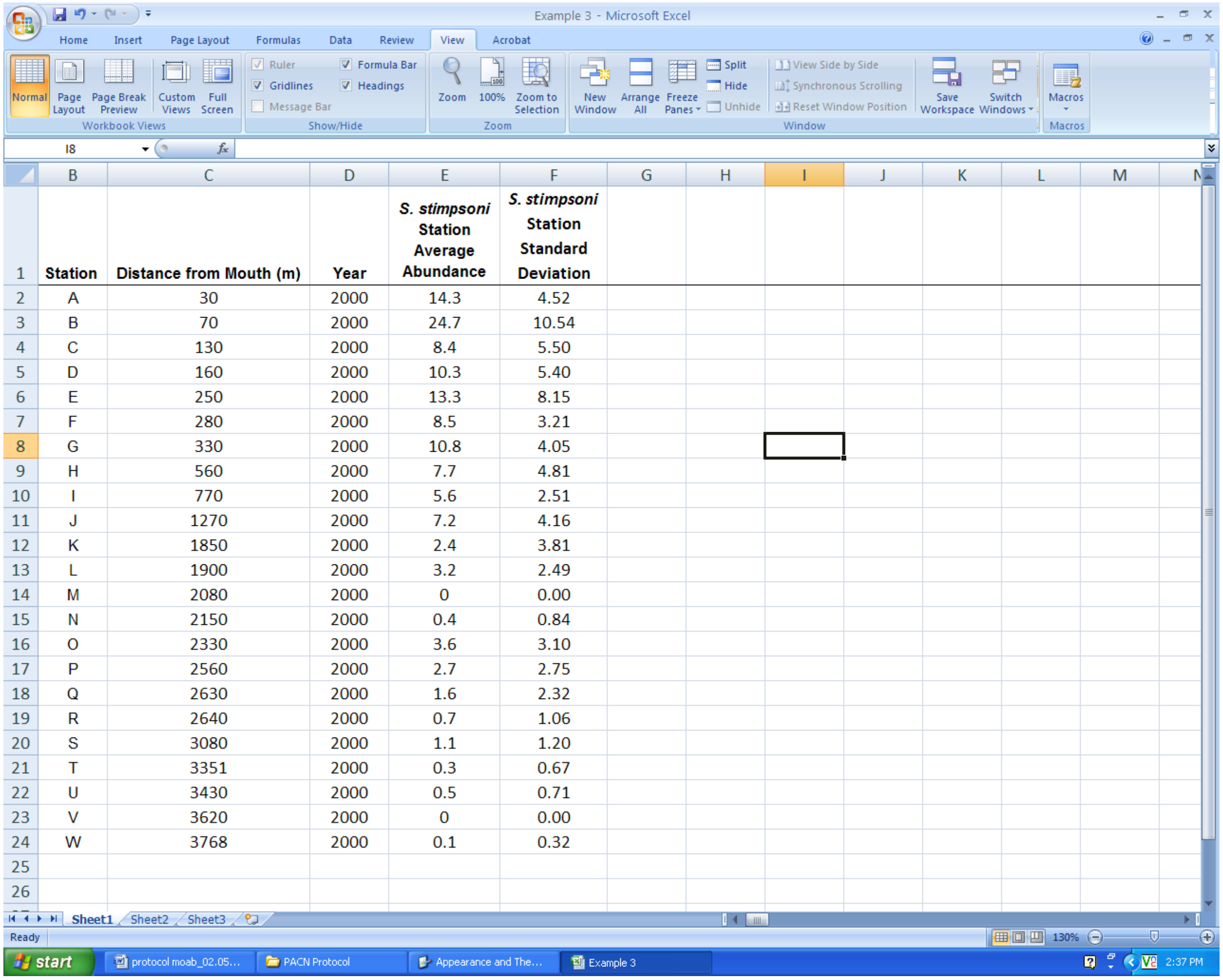


Figure S.32.3. Average station level abundance +/- 1 standard deviation of *S. stimpsoni* at Station D in Unknown Stream.

Step 4: Repeat this procedure for each species in each segment of each stream for the macrofauna size, abundance, and habitat characteristics data on an annual basis.

Example #3: Stream level analysis of fish abundance data.
Step 1: Copy annual quadrant (or segment in Guam) data for a station from a Microsoft Access® query into Microsoft Excel®.

Step 2: Using quadrant (or segment in Guam) data calculate the average abundance and standard deviation in each segment on a given date for each species. In this example, the 2000 annual average abundance and standard deviation data of *S. stimpsoni* for Unknown Stream at Stations A-W in Unknown Stream is pasted into the Example 3.xls (Figure S.32.4).



Station	Distance from Mouth (m)	Year	*S. stimpsoni* Station Average Abundance	*S. stimpsoni* Station Standard Deviation
A	30	2000	14.3	4.52
B	70	2000	24.7	10.54
C	130	2000	8.4	5.50
D	160	2000	10.3	5.40
E	250	2000	13.3	8.15
F	280	2000	8.5	3.21
G	330	2000	10.8	4.05
H	560	2000	7.7	4.81
I	770	2000	5.6	2.51
J	1270	2000	7.2	4.16
K	1850	2000	2.4	3.81
L	1900	2000	3.2	2.49
M	2080	2000	0	0.00
N	2150	2000	0.4	0.84
O	2330	2000	3.6	3.10
P	2560	2000	2.7	2.75
Q	2630	2000	1.6	2.32
R	2640	2000	0.7	1.06
S	3080	2000	1.1	1.20
T	3351	2000	0.3	0.67
U	3430	2000	0.5	0.71
V	3620	2000	0	0.00
W	3768	2000	0.1	0.32

Figure S.32.4. Average abundance and standard deviation data structure at the stream level in Microsoft Excel®.

Step 3: Create a plot that shows the change in average station abundance and standard deviation over longitudinal distance from the mouth of the stream (Figure S.32.5). This plot represents stream level summarization and range of variation data for *S. stimpsoni* at stations A-W in Unknown Stream in 2000.

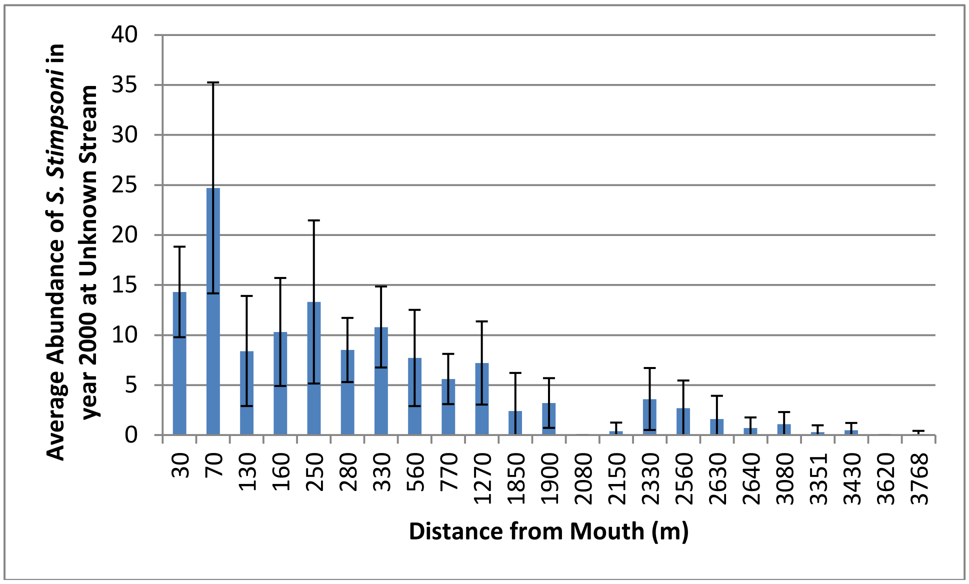


Figure S.32.5. Average stream level abundance +/- 1 standard deviation of *S. stimpsoni* at in year 2000 at Unknown Stream.

Step 4: Repeat this procedure for each species in each stream for the macrofauna size, abundance, and habitat characteristics data on an annual basis.

Reporting Overview

Report Types

Unlike the analysis log files which will generate individual files for each park and each of the three analysis strategies (station, stream, and trend assessment levels), reporting documents will integrate both parks and analysis strategies. Table S.32.3 identifies product types, purposes, targeted audiences, responsible parties, production frequency, and review processes. We have identified a cohesive suite of seven product categories: (1) program and protocol reviews, (2) monitoring protocol and project reports, (3) status and trends reports, (4) scientific writing and presentations, (5) management briefings, (6) website communication, and (7) interpretation and outreach.

Table S.32.3. Summary of anticipated products, grouped by type and frequency.

Type of Report	Purpose of Report	Targeted Audience	Initiated by	Frequency of Reporting	Review Process
Program and Protocol Reviews					
Protocol Review Reports	Document where actual procedures fall short or exceed expectations, recommend necessary changes, document changes since last protocol review report; document overall quality of protocol – particularly in terms of protocol objectives and implementation, effectiveness, and data management.	Superintendents, park resource staff, I&M staff, service-wide program managers, external scientists, partners	PACN aquatic ecologist	Within 1-3 years of implementation, 5-year intervals thereafter	Peer review at network and regional level
Monitoring Protocol and Project Reports					
Vital Signs Monitoring Protocol Reports	Document and archive annual monitoring activities and data, describe current resource condition and core analysis results, document related data management activities, document changes in monitoring protocol, communicate monitoring efforts to resource managers. During protocol development stages, will emphasize progress made and challenges encountered.	Park resource staff, PACN staff, external scientists, partners	PACN aquatic ecologist	Annually, compiled each March	Peer review at network level
Summary of Vital Sign Monitoring Protocol Reports	Same as annual "Vital Sign Monitoring Protocol Reports" above, but highlights key points for non-technical audiences	Superintendents, NPS interpreters, public, partners	PACN aquatic ecologist	Annually, compiled each March	Peer review at network level
Pilot Projects and Monitoring Research Reports	Provide background and methods of monitoring protocol development and other methods related investigations	Park resource managers, PACN staff, external scientists, partners	PACN aquatic ecologist	Variable with annual status reporting, as necessary	Peer review at network level plus review appropriate to final product
Status and Trends Reports					

Table S.32.3. Summary of anticipated products, grouped by type and frequency (continued).

Type of Report	Purpose of Report	Targeted Audience	Initiated by	Frequency of Reporting	Review Process
Trend Analysis and Synthesis Reports	Describe and interpret patterns/trends of monitored resources, identify new characteristics of resources and correlations among monitored resources, identify relationships between drivers/stressors and responses, recommend changes to management of resources (adaptive management feedback).	Park resource managers, PACN staff, external scientists, partners	Aquatic ecologist, park leads	3-5 year intervals. Abbreviated annual edition, as necessary for PACN Vital Signs Program	Peer review at the network and regional level
Summary of: Trend Analysis and Synthesis Report	Executive summary of “Trend Analysis and Synthesis Report” above with key points on one page for non-technical audiences. Usually this is a bulleted list.	Superintendents, NPS interpreters, public, partners	Aquatic ecologist	Commensurate with reporting activity of “Trend Analysis and Synthesis Report”	Peer review at the network level
PACN contribution to NPS-wide “State of the Parks” Report	Describes current conditions of park resources, reports interesting trends and highlights of monitoring activities, identifies resource issues of concern, explores future issues and directions	Congress, budget office, NPS leadership, superintendents, general public	Compiled by the Washington Support Office (WASO) from data provided by networks	Annual	Peer review at national level
Scientific Writing and Presentations					
PACN Vital Signs Monitoring Conference	Review and summarize information on this Vital Sign, help identify emerging issues and generate new ideas	Park resource staff, network staff, external scientists, partners	PACN aquatic ecologist	Biennial (around time PACN “Status and Trends Report” is published)	Peer review at national level
Scientific journal articles and book chapters	Document and communicate advances in knowledge, provides a broader perspective on quality assurance and peer review	External scientists, park resource managers, and professional staff	Aquatic ecologist, others	Variable	Peer review according to journal or book standards
Other symposia, conferences and workshops	Review and summarize information on this Vital Sign, help identify emerging issues and generate new ideas	External scientists, professional staff, park resource managers, and other resource managers.	Aquatic ecologist, others	Variable (e.g., Hawaii Conservation Conference, George Wright Society)	Peer review at network level; for papers may also be peer reviewed

Table S.32.3. Summary of anticipated products, grouped by type and frequency (continued).

Type of Report	Purpose of Report	Targeted Audience	Initiated by	Frequency of Reporting	Review Process
Management Briefings					
Protected area managers briefing	Communicate highlights and potential management action items, with 1-2 page briefing statements for each protocol	Park resource staff, Network staff, agency, academic scientists, other Federal, State, and Territorial Protected Area managers, discipline specialists, interpretive staff	Network program manager,aAquatic ecologist	Annually, likely in conjunction with Board of Directors administrative meetings	Peer review by network, PICRP, and monitoring staff
Executive briefings	Update superintendents and other VIPs on park-specific findings and potential resource issues; suggest action items where appropriate	Individual Superintendents and other VIPs	Aquatic ecologist, network program manager, park leads	As needed	Peer review by network, PICRP and monitoring staff
Website Posting					
Web-based media	Centralized repository of all final reports to ensure products are easily accessible in commonly-used electronic formats; other synthesized information on the PACN	Superintendents, park resource staff, PACN staff, service-wide program managers, external scientists, partners, students, public	Variable, typically network webmaster	As media is completed	Peer review at network level to NPS web standards as finalized, reviewed products

Table S.32.3. Summary of anticipated products, grouped by type and frequency (continued).

Type of Report	Purpose of Report	Targeted Audience	Initiated by	Frequency of Reporting	Review Process
Interpretation and Outreach					
Science Days	Communicate main monitoring findings as well as underlying data; discuss potential significance for management, further monitoring, potential additional research needs, and for outreach	Superintendents, park resource staff, PACN staff, protocol managers, partners, public	Aquatic ecologist, biological technician, and others as needed	Variable by park, annual when possible	Meeting / presentation itself is a form of review
Interpretive Conversations	Interactive conversations with park interpretive staff to discuss main monitoring findings as well as underlying data; discuss potential significance for management, further monitoring, potential additional research needs, and for outreach	Park interpretive staff, environmental educators, PACN staff	Aquatic ecologist, biological technician, and others as needed	Variable by park, at least annual when possible	Meeting / presentation itself is a form of review
Park Interpretive / outreach sessions	Review and summarize information on PACN Vital Signs; engage and involve greater participation in monitoring efforts	Park staff, public, partners	Aquatic ecologist, biological technician, and others as needed	Variable	Peer review by network, PICRP staff
Park staff meetings (results synthesis)	Communicate results to non-technical audiences, discuss potential significance for management, receive feedback on resource and monitoring issues in park operations	All park staff, volunteers, and partners, especially those not typically encountered in I&M program, RM, science operations	Aquatic ecologist, biological technician, and others as needed	Annually for each network park	Peer review by network, PICRP staff

Figure S.32.6. Image example of one site of actual field data collection upon which reports should be based.

Report Preparation Process

Reports identified in Table S.32.3 are to be based on collected data (Figure S.32.6) and other science-based documentation. An example summary report of vital signs data that could be presented to park superintendents is included in Appendix 15: “Pacific Islands Stream Monitoring Report: Example Summary of Vital Signs Data.” These reports will provide context and explanations for the results presented, as well as include any additional analyses that may result from initial investigations. The ‘analysis log’ files will serve as the basis for most of the reporting results. The biological technician for this Vital Sign is identified as the primary individual responsible for updating the analysis log files and will also be pivotal in preparation of subsequent reports. It is anticipated that the aquatic ecologist or another statistically trained individuals will be responsible for the statistical analyses.

Drafts of the reporting products will be organized according to the categories outlined above, with key versions and review comments archived, and final versions clearly communicated to PACN network staff to ensure distribution via websites and other channels.

References

Tabachnick, B. G., and L. S. Fidell. 1996. Using multivariate statistics (3rd ed.). New York: Harper Collins, New York, New York, USA.

Standard Operating Procedure (SOP) #33:
Sensitive Information Procedures

Version 1.01

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

Although it is the general NPS policy to share information widely, the NPS also realizes that providing information about the location of park resources may sometimes place those resources at risk of harm, theft, or destruction. This can occur, for example, with regard to caves, archeological sites, tribal information, and rare plant and animal species. Therefore, information will be withheld when the NPS foresees that disclosure would be harmful to an interest protected by an exemption under the Freedom of Information Act (FOIA). The National Parks Omnibus Management Act, Section 207, 16 U.S.C. 5937, is interpreted to prohibit the release of information regarding the "nature or specific location" of certain cultural and natural resources in the national park system. Additional details and information about the legal basis for this policy can be found in the NPS Management Policies[16] (National Park Service 2006), and in Director's Order #66[17].

These guidelines apply to all PACN staff, cooperators, contractors, and other partners who are likely to obtain or have access to information about protected NPS resources. The Project Lead has primary responsibility for ensuring adequate protection of sensitive information related to this project.

The following are highlights of our strategy for protecting this information:

[16] http://www.nps.gov/policy/mp/Index2006.htm
[17] http://data2.itc.nps.gov/npspolicy/DOrders.cfm

1) *Protected resources*, in the context of the PACN Inventory and Monitoring Program, include species that have state or federal status, and other species deemed rare or sensitive by local park taxa experts.

2) *Sensitive information* is defined as information about protected resources which may reveal the "nature or specific location" of protected resources. Such information must not be shared outside the National Park Service, unless a signed confidentiality agreement is in place.

3) In general, if information is withheld from one requesting party, it must be withheld from anyone else who requests it, and if information is provided to one requesting party without a confidentiality agreement, it must be provided to anyone else who requests it.

4) To share information as broadly as legally possible, and to provide a consistent, tractable approach for handling sensitive information, the following shall apply if a project is likely to collect and store sensitive information:
   a. Random coordinate offsets of up to 2 km for data collection locations, and
   b. Removal of data fields from the released copy that are likely to contain sensitive information.

What Kinds of Information Can and Cannot Be Shared?

Do not share: Project staff and cooperators should not share any information outside NPS that reveals details about the "nature or specific location" of protected resources, unless a confidentiality agreement is in place. Specifically, the following information should be omitted from shared copies of all data, presentations, reports, or other published forms of information.

1) *Exact coordinates* – Instead, public coordinates are to be generated that include a random offset azimuth and distance. These offset coordinates can be shared freely.

2) *Other descriptive location data* – Examples may include travel descriptions, location descriptions, or other fields that contain information which may reveal the specific location of the protected resource(s).

3) *Protected resource observations at disclosed locations* – If specific location information has already been made publicly available, the occurrence of protected resources at that location cannot be shared outside NPS without a confidentiality agreement. For example, if the exact coordinates for a monitoring station location are posted to a website or put into a publication, then at a later point in time an endangered fish species is observed at that monitoring station, that monitoring station location in reference to the endangered fish species cannot be mentioned or referred to in any report, presentation, data set, or publication that will be shared outside NPS.

Do share: All other information about the protected resource(s) may be freely shared, so long as the information does not reveal details about the "nature or specific location" of the protected resource(s) that aren't already readily available to the general public in some form (e.g., other published material). Species tallies and other types of data presentations that do not disclose the precise locations of protected resources may be shared, unless by indicating the presence of the species the specific location is also revealed (i.e., in the case of a small park).

Details for Specific Products

Whenever products such as databases and reports are being generated, handled, and stored, they should be created explicitly for one of the following purposes:

1) *Public or general use*: These products are intended for general distribution, sharing with cooperators, or posting to public websites. These databases or reports may be derived from products that contain sensitive information so long as the sensitive information is either removed or otherwise rendered in a manner consistent with other guidance in this document.

2) *Internal NPS use*: These are products that contain sensitive information and should be stored and distributed only in a manner that ensures their continued protection. These products should clearly indicate that they are solely for internal NPS use by containing the phrase: "Internal NPS Use Only—Not For Release." These products can only be shared within NPS or in cases where a confidentiality agreement is in place. They do not need to be revised in a way that conceals the location of protected resources.

Data Sets

To create a copy of a data set that will be posted or shared outside NPS:

1) Make sure the public offset coordinates have been populated for each sample or observation location in "tbl_Locations."

2) Delete any database objects that may contain specific, identifying information about locations of protected resources.

The local, master copy of the database contains the exact coordinates and all data fields. The Data Manager and/or GIS Specialist can provide technical assistance as needed to apply coordinate offsets or otherwise edit data products for sensitive information.

Maps and Other GIS Output

General use maps and other geographic representations of observation data that will be released or shared outside NPS should be rendered using offset coordinates, and should only be rendered at a scale that does not reveal their exact position (e.g., 1:100,000 maximum scale).

If a large-scale, close-up map is to be created using exact coordinates (e.g., for field crew navigation, etc.), the map should be clearly marked with the following phrase: "Internal NPS Use Only—Not For Release."

The Data Manager and/or GIS Specialist can provide technical assistance as needed to apply coordinate offsets or otherwise edit data products for sensitive information.

Presentations and Reports

Public or general use reports and presentations should adhere to the following guidelines:

1) Do not list exact coordinates or specific location information in any text, figure, table, or graphic in the report or presentation. If a list of coordinates is necessary, use only offset coordinates and clearly indicate that coordinates have been purposely offset to protect the resource(s) as required by law and NPS policy.

2) Use only general use maps as specified in the section on maps and other GIS output.

If a report is intended for internal use only, these restrictions do not apply. However, each page of the report should be clearly marked with the following phrase: “Internal NPS Use Only—Not For Release.”

Voucher Specimens

Specimens of protected taxa should only be collected as allowed by law. Labels for specimens should be clearly labeled as containing sensitive information by containing the following phrase: “Internal NPS Use Only—Not For Release.” These specimens should be stored separately from other specimens to prevent unintended access by visitors. As with any sensitive information, a confidentiality agreement should be in place prior to sending these specimens to another non-NPS cooperator or collection.

Procedures for Coordinate Offsets

1) Process GPS data, upload into the database, and finalize coordinate data records.

2) Set the minimum and maximum offset distances (project-specific, typically up to 2 km).

3) Apply a random offset and random azimuth to each unique set of coordinates.

4) Coordinates may then be either rounded or truncated so the UTM values end in zeros to give a visual cue that the values are not actual coordinates.

5) Do not apply independent offsets to clustered or otherwise linked sample locations (e.g., multiple sample points along a transect). Instead, either apply a single offset to the cluster so they all remain clustered after the offset is applied, or apply an offset to only one of the points in the cluster (e.g., the transect origin) and store the result in the public coordinates for each point in that cluster.

6) These “public” coordinates are then the only ones to be shared outside NPS – including all published maps, reports, publications, presentations, and distribution copies of the data set – in the absence of a confidentiality agreement.

The following components can be used to create individual offsets rounded to the nearest 100 meters in MS Excel:

1) Angle = rand() * 359

2) Distance = ((Max_offset – Min_offset) * rand() + Min_offset)

3) Public_UTME = Round(UTME_final + (Distance * cos(Radians(Angle – 90))), -2)

4) Public_UTMN = Round(UTMN_final + (Distance * sin(Radians(Angle + 90))), -2)

Sharing Sensitive Information

Refer to SOP #34: "Product Posting and Distribution" for a more complete description of how to post and distribute products, and to keep a log of data requests.

No sensitive information (e.g., information about the specific nature or location of protected resources) may be posted to the IRMA Portal[18] or another publicly-accessible website, or otherwise shared or distributed outside NPS without a confidentiality agreement between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Only products that are intended for public/general-use may be posted to public websites and clearinghouses – these may not contain sensitive information.

Responding to Data Requests

If requests for distribution of products containing sensitive information are initiated by the NPS, by a federal agency, or by a partner organization (e.g., a research scientist at a university), the unedited product (e.g., the full data set that includes sensitive information) may only be shared after a confidentiality agreement is established between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. All data requests will be tracked according to procedures in SOP #34: "Product Posting and Distribution."

Once a confidentiality agreement is in place, products containing sensitive information may be shared following these guidelines:

1) Always clearly indicate in accompanying correspondence that the products contain sensitive information, and specify which products contain sensitive information.

2) Indicate in all correspondence that products containing sensitive information should be stored and maintained separately from non-sensitive information, and protected from accidental release or redistribution.

3) Indicate that NPS retains all distribution rights; copies of the data should not be redistributed by anyone but NPS.

4) Include the following standard disclaimer in a text file with all digital media upon distribution: "The following files contain protected information. This information was provided by the National Park Service under a confidentiality agreement. It is not to be published, handled, redistributed or used in a manner inconsistent with that agreement." The text file should also specify the file(s) containing sensitive information.

5) If the products are being sent on physical media (e.g., CD or DVD), the media should be marked in such a way that clearly indicates that media contains sensitive information provided by the National Park Service.

[18] http://irma.nps.gov/App/Portal/Home

Confidentiality Agreements

Confidentiality agreements may be created between NPS and another organization or individual to ensure that protected information is not inadvertently released. When contracts or other agreements with a non-federal partner do not include a specific provision to prevent the release of protected information, the written document must include the following standard Confidentiality Agreement:

> *Confidentiality Agreement* - I agree to keep confidential any protected information that I may develop or otherwise acquire as part of my work with the National Park Service. I understand that with regard to protected information, I am an agent of the National Park Service and must not release that information. I also understand that by law I may not share protected information with anyone through any means except as specifically authorized by the National Park Service. I understand that protected information concerns the nature and specific location of endangered, threatened, rare, commercially valuable, mineral, paleontological, or cultural patrimony resources such as threatened or endangered species, rare features, archeological sites, museum collections, caves, fossil sites, gemstones, and sacred ceremonial sites. Lastly, I understand that protected information must not be inadvertently disclosed through any means including websites, maps, scientific articles, presentations, and speeches.

Freedom of Information (FOIA) Requests

All official FOIA requests will be handled according to NPS policy. The Project Lead will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

References

National Park Service. 2006. Management Policies. Retrieved February 6, 2007, from: http://www.nps.gov/policy/mp/policies.htm.

Standard Operating Procedure (SOP) #34:
Product Posting and Distribution

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure document provides details on the process of posting and otherwise distributing finalized data, reports and other project deliverables. For a complete list of project deliverables, refer to SOP #30: "Product Delivery Specifications."

Product posting and distribution

Once digital products have been delivered and processed, the Data Manager will post the products to the IRMA Portal[19]. The IRMA Portal is the NPS clearinghouse for natural resource products that are available to the public. The following sets of products are available in the IRMA Portal:

1) Full metadata records and datasets will be posted to the References service within the IRMA Portal and made available to the public.
2) A record for reports and other publications will be created in the Reference service. The digital report file in PDF format will then be uploaded and linked to the reference record.
3) Species observations will be extracted from the database and entered into the Biology service which is the NPS database and application for maintaining park-specific species lists and observation data.

The IRMA Portal serves as the primary mechanism for sharing reports, data, and other project deliverables with other agencies, organizations, and the general public.

[19] http://irma.nps.gov/App/Portal/Home

Holding period for project data

To protect professional authorship priority and to provide sufficient time to complete quality assurance measures, there is a two year holding period before posting or otherwise distributing inalized data. This means that certified data sets are first posted to publicly-accessible websites (i.e., the IRMA Portal) approximately 24 months after they are collected (e.g., data collected in June 2006 becomes generally available through the IRMA Portal in June 2008). In certain circumstances and at the discretion of the project lead and park biologists, data may be shared before a full two years have elapsed.

Note: This hold only applies to raw data; all metadata, reports or other products are to be posted to the IRMA Portal in a timely manner as they are received and processed.

Responding to Data Requests

Occasionally, a park or project staff member may be contacted directly regarding a specific data request from a federal agency, an organization, scientist, or from a member of the general public. The following points should be considered when responding to data requests:

1) NPS is the originator and steward of the data, and the NPS Inventory and Monitoring Program should be acknowledged in any professional publication using the data.

2) NPS retains distribution rights: copies of the data should not be redistributed by anyone but NPS.

3) The data that project staff members and cooperators collect using public funds are public records and as such cannot be considered personal or professional intellectual property.

4) No sensitive information (e.g., information about the specific nature or location of protected resources) may be posted to the IRMA Portal or another publicly-accessible website, or otherwise shared or distributed outside NPS without a confidentiality agreement between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Refer to the section in this document about sensitive information and also to SOP #33: “Sensitive Information Procedures.”

5) For quality assurance, only the certified, finalized versions of data sets should be shared with others.

The Project Lead will handle all data requests as follows:

1) Discuss the request with other park biologists as necessary to make those with a need to know aware of the request and, if necessary, to work together on a response.

2) Notify the Data Manager of the request if s/he is needed to facilitate fulfilling the request in some manner.

3) Respond to the request in an official email or memo.

4) In the response, refer the requestor to the IRMA Portal, so they may download the necessary data and/or metadata. If the request can not be fulfilled in that manner – either because the data products have not been posted yet, or because the requested data include sensitive information – work with the Data Manager to discuss options for fulfilling the request directly (e.g., burning data to CD or DVD). Ordinarily, only certified data sets should be shared outside NPS.

5) If the request is for a document, it is recommended that documents be converted to PDF format prior to distributing it.

6) If the request is for data that may reveal the location of protected resources, refer to the section in this document about sensitive information and also to SOP #33: "Sensitive Information Procedures."

7) After responding, provide the following information to the Data Manager, who will maintain a log of all requests in the PACN Project Tracking database:
    a. Name and affiliation of requestor
    b. Request date
    c. Nature of request
    d. Responder
    e. Response date
    f. Nature of response
    g. List of specific data sets and products sent (if any)

All official FOIA requests will be handled according to NPS policy. The Project Lead will work with the Data Manager and the FOIA representative(s) of the park(s) for which the request applies.

Special procedures for sensitive information
Products that have been identified upon delivery by the Project Lead as containing sensitive information will either be revised into a form that does not disclose the locations of sensitive resources, or withheld from posting and distribution. When requests for distribution of the unedited version of products are initiated by the NPS, by an agency, or by a partner organization (e.g., a research scientist at a university), the unedited product (e.g., the full data set that includes protected information) may only be shared after a confidentiality agreement is established

between NPS and the other organization. Refer to SOP #33: “Sensitive Information Procedures” for more information.

Standard Operating Procedure (SOP) #35:
Revising the protocol

Version 1.00

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

Purpose

This Standard Operating Procedure explains how to make and document changes to the Stream Macrofauna (fish, shrimp, and snails) Vital Sign Monitoring Protocol narrative and associated Standard Operating Procedures (SOPs) for the Pacific Island Network. Anyone editing the Protocol Narrative or any one of the SOPs needs to follow this outlined procedure in order to eliminate confusion in how data is collected, managed, analyzed, or reported. All personnel should be familiar with this SOP in order to identify and use the most current methodologies.

The following procedures must be followed when making changes to ensure that previous data collection and processing procedures are clearly understood and accounted for when using and interpreting historical data sets. Similarly, clearly articulating new methods is key to credible interpretation of data acquired since the implementation of changes. Personnel making changes must be familiar with this SOP to ensure that proper reviews are conducted, and that documentation standards are followed.

Procedures:

1) Modifications. Modifications must be reviewed for clarity and technical soundness. Small changes or additions to existing methods will be reviewed in-house by PACN Inventory and Monitoring staff. An outside review will be encouraged by the networks for whole-scale changes in methods. Major changes will be reviewed by regional and national staff of the National Park Service and experts outside of the park service with familiarity in stream monitoring and data analysis.

2) Records. All changes must be documented, and updated protocol versions must be recorded in the Revision History Log that accompanies the Protocol Narrative and each SOP. Changes are recorded only in the Protocol Narrative of the SOP being modified. Version numbers increase incrementally by hundredths (e.g. version 1.01, version 1.02, etc.) for minor changes. Major revisions will be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 …). Record the previous version number, new version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, the reason for making the changes, and the person who approved the revision.

3) Narrative and SOP updates may occur independently. A change in one SOP will not necessarily invoke changes in other SOPs, and a narrative update may not require SOP modifications. All narrative and SOP version changes must be noted in the Master Version Table (MVT), which is maintained in this SOP. Any time a narrative or an SOP version change occurs, a new Version Key number (VK#) must be created and recorded in the MVT, along with the date of the change and the versions of the narrative and SOPs in effect. The VK number increments by whole integers (e.g., 1,2,3,4,5). Updates to the MVT also must be provided to the Data Manager for inclusion in the Master Version Table database. The Version Key number is essential for project information to be properly interpreted and analyzed. The protocol narrative, SOPs, and data should not be distributed independently of this table.

4) New versions. New versions of the Protocol Narrative and SOPs must be posted on the PACN web page. Previous versions of the Protocol Narrative and SOPs must be archived in the appropriate library.

Rationale

The stream monitoring protocol narrative and associated SOPs for the Pacific Island Network represents an effort to document and employ scientifically rigorous methodologies for collecting, managing, analyzing, and reporting benthic marine community monitoring data and information. However, all protocols, regardless of initial rigor require editing as new and different information, techniques, or technologies become available. Required edits should be made in a timely manner and appropriate reviews undertaken. Careful documentation of changes to the protocol, and a library of previous protocol versions are essential for maintaining consistency in data collection and for appropriate treatment of the data during data summary and analysis. The MS Access database for each monitoring component contains a field that identifies which version of the protocol was in use when the data were collected.

In this context of revising the protocol, the rationale for dividing this document into a Protocol Narrative with supporting SOPs is based on the following:

1) The Protocol Narrative is a general overview of the protocol that gives the history and justification for monitoring and an overview of the sampling methods, but does not provide all of the methodological details. The Protocol Narrative will only be revised if major changes are made to the protocol.

2) The SOPs, in contrast, are very specific step-by-step instructions for performing a given task. They are expected to be revised more frequently than the protocol narrative.

3) When an SOP is revised, in most cases, it is not necessary to revise the Protocol Narrative to reflect the specific changes made to the SOP.

4) All versions of the Protocol Narrative and SOPs will be archived in a Protocol Library.

Procedure

All edits require review for clarity and technical soundness. Small changes or additions to existing methods should be reviewed in-house by Pacific Island Network staff (e.g., version changes by hundredths). However, if there is a complete or major change in methods, then an outside review may be required (e.g., version changes by whole numbers). If there is a major change in methodology, either to the entire protocol or individual SOPs or narrative components, the Program Manager of the Pacific West Region Inventory and Monitoring Program should be consulted to determine the appropriate level of peer review required. Typically, regional and national staff of the NPS, and outside experts in government, private sector, and academia with familiarity in stream monitoring in the Pacific Islands will be utilized as reviewers.

Metadata

Any changes to associated database design and organization are documented in the Metadata of the project database(s).

Notification

The Data Manager should be informed about changes to the Protocol Narrative or SOPs so the new version number can be incorporated in the Metadata of the project database. Changes in the Protocol Narrative or SOPs may require the Data Manager to edit the database.

The appropriate PACN staff should be notified of the changes and appropriate level review process initiated, as determined collaboratively by the network staff and Project Lead.

Once review comments are received, incorporated, and approved, the Project Lead should post revised versions on the internet and forward copies to all individuals with a previous version of the affected Protocol Narrative or SOPs. The PACN Data Manager should also be provided with this documentation for inclusion in the network's protocol library.

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