Inventory & Monitoring Protocols – Fishes In Small Streams			
Survey Level	**Questions**	**Methods**	**Products**
Preliminary (office-oriented)	• Which researchers and knowledgeable people have information on the system and insights for effective inventory and monitoring? • What literature and potential inventory and monitoring methods are relevant to this system?	• Intensive literature review. Consult knowledgeable people • Identify species present and habitat types from previous studies. Note sample methodology and catch variability. Note rare or protected species • Familiarize yourself with potential species. Visit fish collections.	• Library of previous studies and relevant sampling methodology. • Partial or preliminary species list. • Data and products from previous or similar studies.
Reconnaissance (field-oriented)	• What is the general type and distribution of habitat(s)? • Can we initially rule out any sampling gear and methodology? • How accessible is this system?	• Site visit with ground-truthing: Walk enough creeks to locate and map all general habitat types and their distribution. Make casual visual observations of fish present. • Note possible difficulties for potential sampling gears (e.g. large snags, thick aquatic vegetation, high water velocity, turbidity, low/thick bank vegetation, conductivity, tidal action, deep water, sensitive species and habitat). • Conduct preliminary watershed/drainage basin assessment: identify geomorphic properties, stream order, base flow, elevation, historic and present land use, basin land cover. Identify water body: water body type, position identification (lat, long/UTM), descriptive attributes (name, ownership, accessibility). **(4: ch.4-5; 19: ch.2)**	• Basic info on past and present land use as well as present and potential fish community. • Basic info on habitat quality and quantity. • Rough map of major habitat distribution. • Initial assessment of potential sampling gear and methodology.
Baseline (field-oriented)	• Which aquatic and terrestrial habitats directly or indirectly contribute to ecological and physical processes in the aquatic system? What is the structure of these habitats? How are they distributed? • What are the basic physical and biological attributes of the aquatic system? How do they change through time?	• Intensive habitat assessment: Seasonal measurements describing spatial and temporal variation in physical, chemical and biological attributes. Stream reach survey measurements and classification of streams and reaches **(4: ch. 6-7; 57: ch.4)**. Macrohabitat identification, substrate analysis, cover and refuge assessment, stream bank condition, associated terrestrial vegetation, water flow, water temperature, water clarity, water chemistry (DO, H-ion concentration, alkalinity, hardness, total dissolved solids, nitrate, phosphorus) **(4: ch.8-12, 14, 15, 17, 18; 18; 19: ch.3)**. • Baseline-level gear evaluation performed in an experimental manner with sufficient sample effort to allow for basic statistical comparisons **(84)**. Qualitative assessment may also be important. Gear comparison studies found in literature for similar habitats and similar species may be sufficient. Include gear types and methodology that target specific life stages (Ichthyoplankton **(8, 10, 57: ch. 9)**, escapement/redd and carcass surveys **(19: ch.4)**). • Measure catch efficiency: Mark-recapture studies **(49, 41, 78, 65, 57: ch.11)** or rotenone (often not appropriate) or seining **(40, 45)** have been used to estimate 'actual' populations in an area and can be used to estimate catch efficiency.	• Intensive habitat assessment. • Species richness • General relative abundance and temporal trends in fish abundance. • Selection of effective gear for Comprehensive Level study. • Quantified catch efficiency for Comprehensive Level inventory and monitoring gear.

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Baseline (cont.)	• Which gear and sampling methodology will be most effective for documenting changes in the abundance of various fish species within the aquatic system (answer Comprehensive Level questions) **(72)**. • What will be the cost of Comprehensive Level inventory and monitoring?	• <u>Seining</u>: One of the most common gear types. Used in lakes, estuaries, streams, rivers and marine environments. Most effective for slow moving water, areas with even and firm substrate and also little or no aquatic vegetation. Limited by water depth. Can be fairly disruptive to habitat. Seining has been effective in assessing species richness and/or abundance and habitat value **(84, 81, 79, 23, 22, 57: ch.7)**. • <u>Electrofishing</u>: A very common method for sampling fishes. Typically used as boat-mounted devices for lakes, estuaries and large rivers and as backpack-models for streams **(57: ch.8)**. Can be used in higher water velocities and in areas with uneven substrates and obstructions in the water column. Limited by water depth and conductivity. Can be accomplished with little disruption to habitat. Effect of electrofishing on fish populations is a concern **(58)**. Electrofishing has been effective in assessing species richness and/or abundance and habitat value **(3, 85, 84, 77, 69, 67, 63, 55, 52, 51, 48, 43, 30, 29, 21, 7, 2)**. • <u>Enclosures</u>: examples: Encircling net, block net, purse seine, flume weir, drop net, throw trap, drop sampler. Commonly used for lakes and estuaries. Can be effective for a variety of habitats. Most of these are limited by water depth and substrate obstructions. Can be disruptive to habitats with aquatic vegetation. Enclosures have been effective in assessing species richness and/or abundance and habitat value. • <u>Visual surveys</u>: Can be an effective way to inventory and monitor fish populations. Can be used in deep water and in areas with substrate and water column obstructions. Can detect larger fish that may evade sampling gear. Relatively low time and cost requirements. Requires good visibility and sharp ID skills. Data on size class is often qualitative. Can be accomplished with very little disruption to habitat. Has been effective for measuring fish abundances **(80, 59, 29, 26, 22, 21, 57: ch19)**. Effective for anadromous salmonid reproduction assessment. • <u>Toxicants</u>: Have been widely used in lakes, estuaries, rivers and streams. This method may have a particular value for State Parks, but possible negative effects should be seriously considered **(57: ch.10)**. • <u>Towed nets</u>: examples: otter trawl, beam trawl, bottom sled, surface trawl. Used for large bodies of water **(57: ch.7)**. Have been used to develop indices of abundance. Can sample large areas. Typically require a boat. Often have low and highly variable catch efficiency. It is difficult to use towed nets to accurately measure juvenile and adult fish abundances. Towed nets can be an effective way to sample ichthyoplancton. • <u>Passive sampling gear (general)</u>: Channel net, fyke net, flume net, berder trap, pit trap, light trap, gill net. Typically used in lakes, estuaries and larger rivers **(57: ch.6)**. Channel, fyke and flume work well with tidal influence and river flow. Large areas can be sampled and many samples obtained. Catch efficiency usually not measurable. Highly selective catch. Passive samplers are typically not good at accurately measuring abundances.	

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Comprehensive (field-oriented)	• What are the total and relative abundances of fish species present? • Which habitat types and physical variables are associated with abundance and distribution of aquatic organisms? • What are the limiting factors for optimum productivity of the system? • What methodology will be used for Comprehensive Level monitoring program?	• Random selection of sample sites within each habitat type. Systematic sampling is a potential alternative to random sampling. • Choose the appropriate number of samples that minimizes costs but still has enough statistical power to detect meaningful differences **(9, 62, 15, 17, 53, 32, 14, 24).** If electrofishing, chose the appropriate number of passes per sample **(3, 77, 69, 67, 55, 48, 43, 30)**. • Select appropriate sample unit size and balance that sample unit size with the sample number. This may vary due to density, distribution, behavior and size of targeted species; on the complexity of habitats; and on the objectives of the study. • Sample at similar water levels **(51, 43, 25, 24)**. • Sample seasonally for at least one year. • Sample throughout the diel cycle. • Target all life stages, if possible. • Standardize gear deployment and sampling methodology (inconsistencies in gear specifications or how a gear is used may influence catch efficiency). • Catches from multiple sampling gears have been integrated to describe fish assemblages throughout heterogeneous habitats **(83, 38, 29, 22, 21)**.	• Intensive habitat assessment • Species richness • Total and relative abundances and spatial and temporal trends. • Development of biological indices **(27, 1, 28, 54)**. • Reference data and study-plan for comprehensive level monitoring program. • Identification of habitat value.
Intensive (field- & laboratory-oriented)	• What are the ecological and biological processes that structure this system?	• Scale and otolith work. • Diet analysis. • Genetic analysis. • Tissue and water samples for toxicology studies. • Specific research projects.	• Population estimates with age structure and size class distribution. • Feeding habits and trophic relationships. • Reproductive behavior, timing and requirements. • Possible toxicity issues identified. • Species movement and habitat partitioning.