Best Available Science

Streams and Fish and Wildlife Habitat Conservation Areas

Prepared for the City of Sammamish

by AMEC Environment and Infrastructure Inc.

Introduction

The City of Sammamish (Sammamish) is in the process of reviewing its Environmental Critical Areas regulations (ECA). Designation and protection of environmentally critical areas must include Best Available Science (BAS) according to the Growth Management Act (GMA, RCW 36.70A). This memo provides a summary of the BAS relevant to fish and wildlife conservation areas (SC 21A.50.325), wildlife habitat corridors (SC 21A.50.327) and streams (SC 21A.50.330-350) and focuses on scientific review articles and government agency guidance documents that have been published since Sammamish last updated its ECA codes in 2005. The intent is to characterize accurately the general conclusions of existing studies and to provide a context for updating the existing ECA.

While this memo discusses fish and wildlife habitat conservation areas (FWHCAs) overall, its primary focus is on streams and riparian areas, beginning with a general review of their ecological functions and a description of how neighboring jurisdictions have addressed them in their ECA regulations. This is followed by a more focused discussion of the environmental conditions that are unique to Sammamish streams and species, how BAS relates to Sammamish ECA regulations given those conditions, and finally, how any existing knowledge gaps might be filled through research and monitoring to protect these ecological functions more effectively given development pressures and other constraints. All citations for documents referenced in this memo are provided at the end, in addition to a list of other useful documents that were reviewed but not cited.

Most counties and cities in the Puget Sound region, including Sammamish, conducted BAS reviews and updated their critical area codes in the middle of the last decade. Since that time, much of the research and review regarding protection of aquatic areas has been driven by the need to develop Shoreline Master Programs. As such, more recent buffers guidance often relates to waters of the state, i.e., marine shorelines, larger lakes, and rivers.

AMEC identified several noteworthy reviews and guidance documents pertaining to ecological functions of streams and riparian buffers published since 2005 (Ecology 2011, Brennan et al 2009, Knight 2009, WDFW 2009, Mayer et al. 2006, Hawes and Smith 2005, Polyakov et al. 2005, May 2003, 2005), but much of the primary literature and scientific research that is referenced in these reviews took place earlier. Because much of the BAS published prior to 2005 is still relevant, we refer to several earlier documents (FEMAT 1993, Castelle et al. 1994, Knutson and Naef 1997, Wenger 1999, Bolton and Shellberg 2001, OCD 2002, CTED 2003, Hickey and Doran 2004, Lee et al. 2004, King County 2004) when discussing recommendations for the ECA update.

Puget Sound-Wide Issues

Streams and riparian corridors provide a wide range of benefits for humans and wildlife, which are often referred to as “ecosystem services.” The value of these ecosystem services has long been recognized and a substantial body of scientific literature describing the structure and function of streams and riparian areas has been developed over the past half century. Some of the functions typical of streams include conveyance of surface water, flood regulation, transport of sediment and nutrients, and aquatic habitat for fish and invertebrates. Riparian areas are critical transition zones that are not only necessary for maintaining the function of the stream, but also provide unique habitat opportunities for terrestrial species. Some of the functions typical of vegetated riparian zones include wildlife habitat, shade/temperature regulations, bank stabilization and erosion control, source of in-stream large woody debris (LWD) and terrestrial-based food supply, filtering of sediment and reduction of total suspended sediments (TSS), retention or removal of nutrients and contaminants, flood storage, and aesthetics. These functions have been well documented and reviewed in the scientific literature, and subsequently incorporated into guidance documents produced by government agencies in the State of Washington (i.e., FEMAT 1993, CTED 2003, WDFW Aquatic Habitat Guidelines Program, and Ecology 2011) and around the country (USACE 1991, Wenger 1999, Desbonnet et al 1994, Lee et al. 2004).

Additional areas that are considered “essential for the preservation of critical habitat and species,” are deemed FWHCAs under Critical Area code. By definition, these FWHCAs include areas where state or federally listed species have a primary association; streams, lakes, or naturally occurring ponds; state conservation areas; and wildlife habitat corridors designated by the King County wildlife habitat network. FWHCAs that are also streams, lakes, ponds, or wetlands are regulated under the provisions for those areas.

One of the primary ways to protect critical areas such as streams and wetlands and to ensure that existing ecological functions and values are maintained is to establish buffers, within which development and other incompatible land uses are prohibited or restricted. Determining the size, shape and other characteristics of a buffer necessary to protect streams and wetlands is not a simple task; the ideal buffer depends on site-specific conditions such as presence of sensitive species, slope, soil type, vegetation, etc., and the type and relative impact of the different processes that act on the system. Considerable study and debate has focused on recommending appropriate buffer widths, and a substantial amount of information exists on the effects of riparian systems on erosion and water quality in forestry (FEMAT 1993, Lee et al. 2004) and agricultural contexts (Hickey and Doran 2004, Polyakov et al. 2005, Mayer et al. 2006).

In a municipal context, many cities prescribe variable width buffers based on the size and type or functional value of the wetland or stream. Wider buffer widths are usually required for larger waterbodies because they provide more ecological functions, particularly relating to habitat. Similarly, waterbodies that have been significantly modified or degraded tend to receive less protection than do high quality, relatively undisturbed waterbodies because their functions have already been degraded.

Regardless of site-specific conditions, there is typically a minimum size or threshold distance required for a buffer to have a measurable ecological benefit. Beyond this distance, there is a positive correlation between the width of a buffer and its effectiveness in protecting the functions and values of the streams itself.

The relationship, however, is non-linear; the positive influence a buffer has on stream conditions tends to diminish significantly with distance from the stream. Other factors, such as the slope of the land bordering the water body, also influence the effectiveness of the buffer with respect to certain ecological functions.

Very basic functions, such as shade and bank stability, can be protected with relatively narrow vegetated buffer strips. In other cases, however, wider buffers are required to maintain wildlife habitat and water quality. To illustrate these variable widths, Table 1 summarizes buffer width recommendations that were presented in a recent review by Brennan et al. (2009), which is the most recent locally relevant review of buffer widths. Their review was conducted ostensibly to recommend buffers for marine shorelines, for use in shoreline master program regulations; however, most of the scientific literature that they review was developed for freshwater systems, which they then adapted and interpreted for marine shorelines. Thus, the summary of BAS developed by Brennan et al. (2009) meets the requirement for BAS for freshwater streams and provides valuable guidance for Sammamish to consider. For comparison, similar summary tables are provided here from older sources focused specifically on buffer width in freshwater systems (Table 2, May 2003; Table 3, Knutson and Naef 1997). Because Brennan et al (2009) identified considerably larger buffer recommendations for water quality and fine sediment control than the earlier studies, AMEC examined the basis for its recommendations more closely. Almost all of the studies Brennan et al (2009) reviewed for these functions pre-dated May (2003). The more recent studies do not recommend buffers larger than did the earlier studies. AMEC believes that May (2003) and Knutsen and Naef (1997) remain acceptable bases for Sammamish to rely on for evaluating its buffer widths for water quality and sediment control functions.

Table 1. Range and average recommended buffer widths to achieve 80% effectiveness of different ecological functions. Adapted from Brennan et al. (2009).

Function	Range of buffer width recommendations (to achieve >80% effectiveness)	Average of all literature (to achieve >80% effectiveness)
Water quality	5 – 600 m (16 – 1,968 ft)	109 m (358 ft)
Fine sediment control	25 – 91 m (92 – 299 ft)	58 m (190 ft)
Shade	17 – 38 m (56 – 125 ft)	24 m (79 ft)
LWD	10 – 100 m (33 – 328 ft)	55 m (180 ft)
Wildlife	73 – 275 m (240 – 902 ft)	174 m (571 ft)

Table 2. Riparian buffer functions and appropriate widths identified by May (2003)

Riparian Function	Range of Effective Buffer Widths (ft)	Minimum Recommended Widths (ft)	Notes on Function
Sediment Removal / Erosion Control	26 – 600	98	For 80% sediment removal
Pollutant Removal	13 – 860	98	For 80% nutrient removal
LWD Recruitment	33 – 328	164	1 SPTH based on long-term natural levels
Water Temperature	36 – 141	98	Based on adequate shade
Wildlife Habitat	36 – 141	328	Coverage not inclusive
Microclimate	148 – 656	328	Optimum long-term support

Source: Herrera (2005)

Table 3. Riparian functions and appropriate widths identified by Knutson and Naef (1997)

Function	Range of Effective Buffer Widths (ft)	Average of Reported Widths (ft)
Sediment Filtration	26 – 300	138
Erosion Control	100 – 125	112
Pollutant Removal	13 – 600	78
LWD Recruitment	100 – 200	147
Water Temperature Protection	35 – 151	90
Wildlife Habitat	25 – 984	287
Microclimate	200 – 525	412

Source: Herrera (2005)

Because they were formed and are acted upon by similar processes, streams in the Puget Sound region share common features. From a regulatory standpoint, it is also important to strive for consistency in the type and degree of protection afforded streams that cross more than one jurisdiction. For these reasons, it is instructive to consider information developed by municipalities located near Sammamish that have attempted to protect critical areas based on BAS and the land use conditions within their jurisdictions. Information developed by neighboring jurisdictions was considered in the review of the existing Sammamish ECA.

The following tables provide a comparison of the stream buffers adopted by neighboring jurisdictions, which were also developed using BAS as mandated by the GMA.

Table 4. Sammamish Critical Area buffers for streams

Stream type	Definition	Buffer width (ft)
S	Waters of the State	150
F	Smaller streams that contain fish habitat*	150
Np	Non-fish-bearing streams, perennial	75
Ns	Non-fish-bearing streams, seasonal	50

* Type F streams include perennial reaches of George Davis, Ebright, Pine Lake, and Laughing Jacobs creeks, which either have documented historical presence of fish or that the City believes could potentially be restored for fish use.

In addition, Sammamish requires a building setback of 15 feet from the edges of critical area buffers.

Table 5. King County Critical Area buffers for streams inside and outside of Urban Growth Areas (UGA)

Stream type	Definition	Buffer width (ft) in UGA	In UGA, with high value habitat conditions	Outside of UGA
S	Shorelines of the state	115	165	165
F	Smaller streams that contain fish habitat	115	165	165
N	Non-fish-bearing streams	65	65	65
O	Streams with no open connection	25	25	25

An exception to these standards is applied in the Bear Creek watershed, where a 100-foot buffer is applied to any N-type stream that lies in a designated regionally significant resource area. In addition, King County requires a building setback of 15 feet from the edges of critical area buffers.

Table 6. Snohomish County Critical Area buffers for streams

Stream type	Definition	Buffer width (ft)
S	Shorelines of the state	150
F with anadromous or resident salmonids	Smaller streams that contain fish habitat	150
F without anadromous or resident salmonids	Smaller streams that do not contain fish habitat	100
Np	Perennial non-fish habitat streams.	50
Ns	Seasonal, non-fish habitat streams	50

Table 7. Issaquah Critical Area buffers for streams

Stream type	Definition	Buffer width (ft)
1	Shorelines of the state	100
2s	Smaller streams that contain salmonid habitat	100
2	Smaller streams that do not contain salmonid habitat	75
3	Non-fish-bearing streams, seasonal	50
4	Constructed, intermittent, no salmon, no connection	25

In addition, Issaquah requires a building setback of 15 feet from the edges of critical area buffers.

Table 8. Redmond Critical Area buffers for streams

Stream type	Definition	Inner Buffer width (ft)	Outer buffer width
I	Shorelines of the state	150	50
II	Natural streams that are not Class I and are either perennial or intermittent and have salmonid fish use or the potential for salmonid fish use	100	50
III	Perennial or intermittent, non-salmonid fish use or the potential for non-salmonid fish use; or Headwater streams with a surface water connection to salmon bearing or potentially salmon bearing streams	100	
IVp	Perennial, do not have fish or the potential for fish, and are non-headwater streams	36	
IVs	Intermittent, do not have fish or the potential for fish, and are non-headwater streams	25	

Table 9. Bellevue Critical Area buffers for streams

Stream type	Definition	Buffer width (ft) Undeveloped site	Buffer width (ft) Developed site	Setback Undeveloped	Setback Developed
S	Shorelines of the state	100	50	20	50
F	Smaller streams that contain fish habitat	100	50	20	50
N	Non-fish-bearing streams	50	25	15	25
O	Streams with no open connection	25	25	10	None

Unique Conditions in Sammamish

The City of Sammamish lies mostly within the East Lake Sammamish Basin. The majority of streams within Sammamish originates in ponds or wetlands on the plateau and then passes through steep, erosive ravines before discharging into the lake (King County 1994). Exceptions occur in a small area of northeast Sammamish that drains via Evans Creek to the Sammamish

River (still within WRIA 8), and along the far eastern edge of the city that drains into the Patterson Creek subbasin on the Snoqualmie River (WRIA 7). Shorelines of the state (Type S) are limited to the Lake Sammamish shoreline and perimeters of Beaver and Pine Lakes. Many of the perennial streams contain spawning habitat for coho salmon, sockeye salmon and kokanee, and cutthroat trout, while a few stream mouths provide rearing habitat for juvenile Chinook salmon (WDFW PHS). FWHCA and wildlife corridors are intended to protect habitat for a wide range of other terrestrial and avian species that are known to occur in Sammamish. These include large mammals such as deer, black bear, bobcat, cougar, and coyote; smaller mammals such as beaver, raccoon, possum, and mice; and a variety of raptors, waterfowl, and songbirds (City Staff, personal communication).

The steep slopes coming down from the plateau are somewhat unique to Sammamish and pose special problems for anadromous salmonids. The upper reaches of streams draining these steep slopes are often too small or steep for adult salmonids to navigate, and therefore are not utilized for spawning or rearing by these species. Erosion of banks and mass wasting events are common, and deliver large quantities of sediment into receiving streams.[1] Sediment, once entrained, is transported downstream into areas occupied by fish. Excess sediment accumulations can reduce the quality of fish habitat in these areas, and in some cases may become a barrier to upstream migration.

Lake Sammamish is considered a natural resource of statewide significance under the Shoreline Management Act. The lake supports a wide variety of aquatic species including threatened and endangered salmonids and popular sport fish species. Water quality in the lake has been a concern, especially concerning phosphorus and related eutrophication and algal production. King County (2012) indicates that, through the latest monitoring in 2008, indicators of eutrophication for Lake Sammamish have generally been stable, in the “good” to “moderate” range. The lake’s surface water temperature, nutrient and pollutant loading, and sediment and organic debris inputs are all affected by Sammamish’s regulations protecting wetlands, streams, and riparian buffers.

Lake Sammamish and the surrounding watershed are home to a unique population of kokanee (sockeye salmon that spend their entire life cycle in freshwater) (Young et al. 2004, Warheit and Bowman 2008). Once abundant in the lake, with thousands to tens of thousands of kokanee spawning in tributary streams every year, the population has declined substantially over the last several decades – since 2006, average run size has been approximately 315 fish (Jackson 2010). A petition to list Lake Sammamish kokanee as endangered species was submitted in 2007 (Trout Unlimited et al 2007), but was recently denied by the USFWS because the population did not meet the criteria of a distinct population segment (USFWS 2011). A partnership of local, state, and federal governments, along with several non-governmental organization and citizen groups have been working together to protect and restore important kokanee spawning habitat and implement an emergency hatchery supplementation program (AMEC 2010, King County 2012).

Only three streams in the Lake Sammamish Basin still support spawning kokanee on a regular basis – Ebright Creek, Laughing Jacobs Creek, and Lewis Creek. The Ebright Creek watershed

[1] The greater incidence of slope failures and other natural and anthropogenic disturbances associated with steep slopes will be addressed in an upcoming AMEC memo on erosion hazards near sensitive waterbodies.

lies entirely within the City of Sammamish, while the headwaters of Laughing Jacobs are partially within the City. It is unclear exactly what factors have driven the decline of kokanee populations but there is some evidence to suggest that altered hydrographs and sediment transport rates may play a role (HDR 2009).

Puget Sound Chinook salmon were listed as threatened under the federal Endangered Species Act in 1999. Since that time, significant funding and resources have been committed to recovery, especially within WRIA 8 (WRIA 8 Chinook Recovery Plan). Chinook salmon are not known to spawn in any of Sammamish's streams, but they do migrate through the Lake to reach spawning habitat and the hatchery in Issaquah Creek. As juveniles, Chinook utilize non-natal stream mouths and tributary deltas (Tabor et al 2004); therefore, the Lake Sammamish shoreline and stream mouths, especially at the south end of the lake near the mouth of Issaquah Creek, are potentially important Chinook habitat.

Implications for Existing City Regulations

In general, the City's stream-typing system, buffer widths, and building setbacks fall within the range of typical BAS-based recommendations and are consistent with neighboring jurisdictions. The expansion of Type F streams to include streams with historic or potentially restorable fish presence provides extra protection for those systems. In a number of cases, neighboring jurisdictions allow for smaller buffers than Sammamish for streams that do not ultimately feed into salmon-bearing waters, particularly if they are intermittent or have human-constructed channels. If there are such streams in Sammamish, then smaller buffers could be considered for them, given their limited ecological functions. However, most Sammamish streams ultimately feed into Lake Sammamish. Given the lake is not only fish-bearing but is highly sensitive to phosphorus inputs, streams that ultimately feed into the lake should generally be protected with at least the 50-foot buffers that are the City's current minimum for intermittent, non-fish-bearing streams.

The other questions most germane to this ECA update relate to flexibilities included in the existing ECA. In general, the City's terms are standard and are mirrored by those of neighboring jurisdictions. However, our review did raise a few concerns related to permitted alterations.

Scientific evidence supports a general paradigm of what ecological functions are important, and can generally describe effects in a qualitative way. However, even when quantitative results are available, and cause-and-effect relationships can be clearly discerned, policymakers need to consider additional factors when interpreting the results and applying them to ECA regulations. For example, in deciding whether buffer reductions should be allowed, BAS can be helpful for qualitatively understanding the direction and magnitude of impacts to particular ecological functions, but the final decision involves balancing a wide range of social, economic, and property rights issues. Site-specific mitigation may justify buffer reductions at a particular location, but it is difficult to predict the cumulative effects of development and mitigation across entire stream basins, especially without assurance that all mitigation will be successful. Given impacts on stormwater, buffers alone will not protect streams as their basins develop.

Lastly, the City's existing definition of "Qualified Professional" for streams and FWHCAs, which emphasizes training and experience in biology, is appropriate, given that the primary ecological functions of these critical areas that drive protective regulations are biological.

Fish and Wildlife Habitat Conservation Areas

Most FWHCA are located in wetland or stream areas and are therefore subject to ECA regulations explained below. When appropriate, increased buffers or seasonal restrictions may also be established based on the type and sensitivity of species found in the area. Under existing ECA regulations, there are few standard guidelines relating specifically to proposed alterations to a FWHCA or its buffer beyond those that would be applied to streams and wetlands under separate parts of the code. A critical areas study prepared by a qualified professional and approved by the City of Sammamish, with guidance provided by the appropriate state and/or federal agencies, may be required to assist with review. Ideally, buffers consist of undisturbed areas of native vegetation. However, this may not be the case in an urban area. Buffer widths for FWHCA are not pre-defined; instead, they are determined based on the sensitivity of habitat and type/intensity of nearby human activity. As allowed in the existing ECA regulations, low impact uses that do not reduce the quantitative and qualitative functions and values of the habitat are permitted within the FWHCA, including pervious trails, viewing platforms, stormwater management facilities such as grass-lined swales, utility easements and other similar uses and development activities. Any impacts to the habitat resulting from such permitted facilities must be fully mitigated.

Regulations specific to FWHCA incorporate flexibility to enable the City tailor its restrictions to a specific site, based on the life history requirements of species of concern, and the existing site conditions. The trade-off is that property owners do not have a predictable set of regulations to guide their planning and may need to prepare a critical areas report, which could involve a significant effort and cost.

No update to the existing FWHCA code is recommended based on BAS.

Wildlife habitat corridors

Under existing ECA regulations, wildlife habitat corridors are intended to protect and preserve connections between habitats along a designated wildlife habitat network. They are established during new development by either setting aside contiguous permanent open space tracts (in subdivisions) or through conservation easements (on individual lots). Corridors must be at least 300 feet wide wherever possible, but never less than 150 feet wide. A management plan for wildlife corridors must be approved by the City and will be used to specify the types of uses that may be permitted within the corridor. Typically, these uses might include limited clearing, pervious trails, and low impact storm water management facilities.

Ecologically, riparian areas function as a special type of wildlife corridor. Therefore, some of the discussion of wildlife habitat in BAS reviews of riparian functions is applicable to a more general consideration of wildlife corridors. One of the consistent conclusions from these reviews is that of all the ecological functions provided by buffers, wildlife habitat typically requires the most space (Brennan et al. 2009, FEMAT 1993). The amount of space will depend on individual habitat requirements of the different species, seasonal changes in habitat use, habitat quality, and connectivity of adjacent habitat areas. In practice, the effective width of the corridor may be substantially less than the corridor's overall width due to a reduction in habitat quality and use by wildlife near its edges (i.e., "edge effect") (Marczak et al. 2010, Fischer and Lindenmayer

2007). Review of BAS by Brennan et al. (2009) report a range of recommended buffer widths for wildlife between 240 to 902 feet, with an average of 571 feet. Based on this information, the wildlife habitat corridor widths required by Sammamish may not be sufficient to provide significant functional value for terrestrial wildlife. Clearly, this depends on the species and their sensitivity to human activity, but in areas where a wildlife corridor is not already constrained by existing development, it is likely that significant benefits would accrue to at least some wildlife species if the minimum required width were increased.

AMEC recommends that Sammamish consider possible amendments to its wildlife corridor regulations based on three primary factors: which wildlife species are of greatest interest to the City to protect; management recommendations from the Washington Department of Fish and Wildlife (WDFW) for those species, if available (website for recommendations is listed in references); and the degree to which existing or potentially new wildlife corridors in the City are already significantly constrained by existing development. While the identification of City interests in protecting particular wildlife species is partly a matter of values, not science, WDFW has created a list of priority species for the state. Species on this list that occur within or near Sammamish, based on review of WDFW's online database and map query (WDFW PHS Query ID: P120405163224), include great blue heron, bald eagle, waterfowl concentrations, purple martin (the largest North American swallow) and Townsend's big-eared bat. WDFW management recommendations for priority species would also apply within FWHCAs.

Streams – Development Standards

Existing ECA codes establish standard buffers around streams (as described above). All fish-bearing streams typically require a 150-foot buffer. New development and most other land uses are prohibited within the buffer. In non-fish-bearing streams, the buffer is either 75 or 50 feet depending on whether the stream is perennial or intermittent. Required buffer widths can be modified based on three different factors:

(1) Buffer width can be averaged if the total area contained in the buffer does not decrease and the buffer is no less than 50% of the minimum standard width at any point;
(2) Buffer width can be increased if the City deems it necessary to protect critical functions or offset other buffer impacts; and,
(3) Buffers can be reduced up to maximum of 50% of standard buffer width if the impacts are mitigated using a variety of techniques to enhance the buffer's function.

Buffer averaging recognizes that the functional value of buffers can vary on any given site. In addition to maintaining total buffer area, the ECA requires that increases be located where buffers provide greater value, while decreases are located where buffers provide less value. The mitigation techniques to qualify for buffer reductions include biofiltration/infiltration mechanisms, removal of impervious surfaces, removal of non-native invasive vegetation, in-stream habitat enhancement, installation of oil-water separators, use of pervious surfaces for driveways or roads, restoration of buffer and habitat areas either on- or off-site, and removal of significant refuse or sources of toxic material. Each of these mitigation techniques allows for an established percent reduction in required buffer width, presumably because they either reduce the need for the full buffer width or improve the function of the remaining buffer. However, each addresses particular buffer functions (mostly relating to stormwater and water quality), rather than the full range of functions that a buffer is supposed to provide. AMEC recommends that the ECA be amended to specify that buffer reductions based on these rationales achieve significant net improvement in the function(s) affected by the mitigation, given that other functions may be harmed by the reduction. This improvement should be demonstrable through monitoring, either for direct performance (e.g., permeability of pavement after 3-5 years) or presumed performance (e.g., plant survival for restoration). Correspondingly, the ECA should also be amended to include criteria that the City must follow to justify increasing buffer requirements. These could include existing high-quality habitat that extends beyond the standard buffer width; steep slopes that reduce the buffer's efficiency in filtering sediments or pollution; highly erosive soils; the presence of sensitive species in buffer areas; and other factors.

Almost all BAS reviews indicate that the capacity of different size buffers to preserve important ecological functions varies with: 1) the ecological function in question and, 2) site-specific conditions relating to slope, hydrology, soil conditions, type of vegetation cover, surrounding land use, etc. Similarly, BAS indicates that a buffer's effectiveness depends as much on the quality of the buffer area as it does on its width (quantity) (Mayer et al. 2006). Therefore, the same level of function may be achieved with different buffer widths at different locations. Conceptually, these principles may justify the practice of buffer reduction or buffer averaging. While it may be possible to develop a quantitative model to calculate precise buffer widths (Polyakov et al. 2005, Dosskey et al. 2005), it may not be possible to achieve results that are within a reasonable range of uncertainty (Hickey and Doran 2004). Furthermore, it is unlikely given the high implementation cost. In the meantime, the City should consider proposed buffer width reductions, averages, and increases in the context of the existing and proposed buffer quality and it appears that the current code allows for this process during review of the critical area study.

Streams – Permitted Alterations

The existing ECA code allows for several types of alterations to streams if important caveats are followed. These include restoration and enhancement of streams and buffers, use for utilities, public and private trails in stream buffers, stream crossings, relocation, stabilization, culvert replacement, ditch maintenance, reconstruction, remodeling, or replacement of an existing structure. Any permitted alteration is required to show that it will not degrade the existing function of the stream or buffer. Requirements for these alterations are generally consistent with those of neighboring jurisdictions. AMEC would suggest, however, some amendments to language on stream relocations and trails.

The current stream relocation language (21A.50.340(8)) does not appear to allow for relocation as part of restoration projects for Type F streams. Language on stream restoration (21A.50.340(12)) does not authorize any stream relocation. Particularly given past human alterations, relocation can be in some circumstances a valuable part of stream restoration.

Sammamish may also wish to reconsider its authorizing relocation of Type F streams for public road, trail, or park projects, consistent with its neighboring jurisdiction Issaquah, where this is not allowed.

Current regulations consider trails with a pervious surface as a low impact land use that is generally permitted in Fish and Wildlife Habitat Conservation Areas, Wildlife Habitat Corridors, and stream buffer areas. Additional construction of viewing platforms, access, or spur trails may be considered if a critical areas study can show that it will not degrade buffer function. Increased buffer widths are required to offset impacts caused by trails, typically such that square footage is replaced at a 1:1 ratio. This approach is consistent with several neighboring jurisdictions (City of Issaquah, City of Redmond, and King County).

BAS does not provide specific guidance on whether or not trails should be allowed within stream and or habitat buffers. Conceptually, many of the ecological functions provided by buffers are most valuable closest to the critical area and decline with distance. This has led to a zoned buffer approach, where increasing intensities of land use are allowed in zones further from the critical area (May 2003). Another issue is the effect of trails and increased human use on wildlife. In general, increasing levels of pedestrians are inclined to reduce species richness and overall abundance of birds (Fernandez-Juricic 2000a, Fernandez-Juricic 2000b, Leung and Marion 2000) and potentially other wildlife.

Sammamish's existing standards for trails in critical area buffers, SMC 21A.30.210, are generally consistent with BAS. AMEC recommends one addition: trails that cross an aquatic area should be constructed as a raised boardwalk or bridge (WDFW 2003).

Streams – Mitigation Requirements

The existing ECA regulations require that the responsible party mitigate for any adverse impacts caused by their actions to streams and/or buffers. Before mitigation measures can be implemented, a mitigation plan must be approved by the City that includes existing conditions and proposed impacts, proposed mitigation, environmental goals and objectives, best available science review, performance standards, detailed construction plans, a monitoring program, and a contingency plan. Mitigation must achieve equivalent or greater environmental function. These provisions are similar to those of neighboring jurisdictions. As discussed in AMEC's BAS report on wetlands, since 2005 substantial new literature has been published on wetland mitigation, which has generally raised concerns about the low success rate of on-site mitigation and the potential advantages of basin- or landscape-scale approaches to off-site mitigation, including in-lieu fee programs. While this literature has generally focused on wetlands, many of the concerns raised would also apply to streams and stream buffers. If Sammamish explores in-lieu fee mitigation programs that could apply to both streams and wetlands, it should consider also adopting this broader approach.

Table 10. Summary of Recommended ECA Code Amendments or Practices

Recommended change	Best Available Science	Professional Experience	Case Law	Statutory Law
Amend wildlife corridor regulations after the City has determined the needs of the species it most wants to protect and the constraints posed by existing development.	WDFW Management Recommendations for identified priority species	Local values can influence “species of concern” chosen for protection		
Require that trails crossing streams and aquatic areas use bridges and raised boardwalks	WDFW (2003)			
Add functional criteria for allowing buffer reductions and requiring buffer additions	Brennan (2009), May (2003), Knutsen and Naef (1997)	The rationale for buffers is based on their multiple functions, so the rationale for modifying them should similarly be function-based	Multiple cases have stressed critical area functions as the basis for their designation and protection	
Authorize relocations of Type F streams for restoration purposes. Amend language authorizing stream restoration to include stream relocation.		Major restoration projects often include relocation of stream reaches, particularly away from roads or other structures		

Research or Monitoring Needs

As discussed above, AMEC recommends that Sammamish consider possible amendments to its wildlife corridor regulations based on three primary factors: which wildlife species are of greatest interest to the City to protect; management recommendations from the Washington Department of Fish and Wildlife (WDFW) for those species, if available; and the degree to which existing or potentially new wildlife corridors in the City are already significantly constrained by existing development. The first factor requires outreach to citizens and stakeholders; the second should generally be available through WDFW’s website for priority habitats and species; the third is a relatively straightforward GIS exercise.

King County is currently researching the effectiveness of its land use regulations in protecting various stream functions, funded by a grant from the U.S. Environmental Protection Agency (King County 2008). While this study focuses on regulations in rural areas, Sammamish may find that its results (available in 2013) will have some bearing on future amendments to the City’s ECA, or on issues that the City should monitor to help inform future amendments.

Much of the scientific literature on buffers is not focused on urban areas. While it is far beyond the capacity of a jurisdiction the size of Sammamish to research how the ecological functions in urban areas may differ from forested or rural environments, the City may be able to collect data through monitoring requirements under the ECA that would be useful for such a research effort. AMEC recommends that the City discuss this with WRIA 8 and state staff. All cities in the Puget Sound area would benefit from additions to the scientific literature that are focused on the real-world choices they must make under the Growth Management Act, as stewards of the part of the Puget Sound ecosystem where the majority of the population lives.

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