HOW TO DETERMINE A HEALTHY STREAM: UNDERSTANDING THE INDEX OF BIOTIC INTEGRITY

What is an Index of Biotic Integrity (IBI)?

IBI is an assessment of environmental quality at a stream site through application of ecologically based metrics to fish community data collected from the site. Fish are useful in determining long - term (several years) effects and broad habitat conditions (throughout the watershed) because they are relatively long - lived and mobile.

How are IBI scores assessed?

The IBI score is the sum of twelve fish community metrics (Table 1). These metrics may be separated into three categories: species richness and composition (Table 2), food preferences or trophic structure (Table 3), and fish abundance and condition (Table 4). Each metric reflects the condition of a portion of the fish community and is scored against expectations under reference conditions. Stated another way, the value for each metric is compared to the value expected at a site located in the same geographical region on a similar - sized stream that is in good ecological condition. Scoring criteria are developed that rate each metric as follows: 5 if its value is close to the maximum expected value; 3 if its value deviates somewhat; 1 if its value deviates strongly from the value expected at a relatively undisturbed site. The scores of the 12 metrics are summed to produce an index for the site or an IBI score. A stream classification can then be determined using a system of attributes and corresponding classifications along the range of possible IBI scores (Table 5).

Table 1. List of Metrics Used in Calculating Index of Biotic Integrity.*

1. Number of native species
2. Number of darter species
3. Number of sunfish species (less Micropterus sp.)
4. Number of sucker species
5. Number of intolerant species
6. Percentage of individuals as tolerant species
7. Percentage of individuals as omnivores
8. Percentage of individuals as specialized insectivorous minnows and darters
9. Percentage of individuals as piscivores
10. Catch rate (average number / unit sampling effort)
11. Percentage of individual as hybrids
12. Percentage of individuals with disease, tumors, fin damage, and other anomalies

*Each is assigned a value as follows: 1 - poor, 3 - intermediate, 5 - the best to be expected. The IBI for a given site is the sum of these values.

Table 2. Species Richness and Composition Metrics Used in Calculating Index of Biotic Integrity.*

Metric 1. **Total number of native fish species** - The more kinds of fishes there are the healthier the stream.

Metric 2. **Number of darter species** - These species decrease with increased degradation; darters are sensitive to siltation and benthic oxygen depletion because they feed and reproduce in benthic habitat.

Metric 3. **Number of sunfish species** - These pool species decrease with increased degradation of pools and insect cover. Most of these fishes feed on drifting and substrate surface benthic macroinvertebrates and are active swimmers.

Metric 4. **Number of sucker species** - This number decreases with increased degradation; suckers are long - lived and therefore serve as an index to physical and chemical habitat degradation over time.

Metric 5. **Number of intolerant species** - This metric distinguishes excellent and good quality sites using species that are intolerant of various chemical and physical perturbations. Intolerant species are typically the first species to disappear following a disturbance. Species classified as intolerant or sensitive should only represent the 5 - 10 percent most susceptible species.

Metric 6. **Percent of species as tolerant species** - This metric is the reverse of Metric #5. It distinguishes poor from fair quality waters. These species show increased distribution or abundance despite historical degradation, and they shift from incidental to dominant in disturbed sites. Tolerant species include: common carp, bullheads, bowfin, creek chub , gizzard shad, green sunfish, longnose gar, spotfin shiner, striped shiner, and white sucker.

* These metrics assess the species richness component of diversity and the types of fish that are pollution tolerant and intolerant..

Table 3. Trophic Structure Metrics Used in Calculating Index of Biotic Integrity. *

Metric 7. **Percent of individuals as omnivores** - The percent of omnivores and herbivores in the community increases as the physiochemical habitat deteriorates. Omnivores are defined as species that consistently feed on substantial proportions of plant and animal material. Species include buffalo, carp, dace, shad, and stonerollers.

Metric 8. **Percent of individuals as specialized insectivores** - Insectivores are the dominant trophic guild of most North American waters. As the invertebrate food source decreases in abundance and diversity due to habitat degradation, there is a shift from insectivorous to omnivorous fish species. This metric evaluates the midrange of biotic integrity. Species include darters, madtoms (small catfishes), minnows, and shiners.

Metric 9. **Percent of individuals as piscivores** - This metric discriminates between systems with high and moderate integrity. Piscivores include the fish that feed exclusively on other fish; occasional piscivores such as creek chub and channel catfish are not included. These species represent popular sport fish such as bass and crappie, in addition to gars and pickerels.

* These three metrics assess the quality of the energy base and trophic dynamics of the community; they evaluate the shift toward more generalized foraging that typically occurs with increase degradation of the physiochemical habitat.

Table 4. Fish Abundance and Condition Metrics Used in Calculating Index of Biotic Integrity.

Metric 10. **Catch rate** - This metric evaluates population abundance and varies with region and stream size. It is expressed as catch per unit effort (number of fish caught per 300 ft. sq. of sampling effort). Generally, sites with lower integrity support fewer individuals, but in some nutrient - poor regions, enrichment increases the number of individuals. Usually, low numbers indicate toxicity, making this metric most useful at the low end of the biological integrity scale.

Metric 11. **Percent of individuals as hybrids** - This metric is an estimate of reproductive isolation or the suitability of the habitat for reproduction. Generally, as environmental degradation increases, the percent of hybrids increases.

Metric 12. **Percent of individuals with disease, tumors, fin damage or other anomalies** - This metric depicts the health and condition of individual fish. These conditions occur seldom at minimally impacted reference sites but occur frequently below point sources and in areas where toxic chemicals are concentrated.

Table 5. Biotic Integrity Classes Used in Assessing Fish Communities along with General Descriptions of Their Attributes (Karr et al. 1986).

Class	Attributes	IBI Range
Excellent	Comparable to the best situations without influence of man; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with full array of age and sex classes; balanced trophic structure.	58-60
Good	Species richness somewhat below expectation, especially due to loss of most intolerant forms; some species with less than optimal abundances or size distribution; trophic structure shows some signs of stress.	48-52
Fair	Signs of additional deterioration include fewer intolerant forms, more skewed trophic structure (e.g., increasing frequency of omnivores); older age classes of top predators may be rare.	40-44
Poor	Dominated by omnivores, pollution - tolerant forms, and habitat generalist; few top carnivores; growth rates condition factors commonly depressed; hybrids and diseased fish often present.	28-34
Very Poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites, fin damage, and other anomalies regular.	12-22
No Fish	Repetitive sampling fails to turn up any fish.	

* use these for lowland streams

Table 5. Fishes of the Tennessee Valley with designations for native species, feeding guild, spawning guild, habitat preference (headwater streams), sensitivity (headwater streams), and tolerance.

headwaters only

COMMON NAME	SCIENTIFIC NAME	* NATIVE	* FEEDING GUILD	SPAWNING GUILD	HABITAT PREFERENCE	SENSITIVITY	* TOLERANCE
OHIO LAMPREY	Ichthyomyzon bdellium	1	PR		P		
CHESTNUT LAMPREY	Ichthyomyzon castaneus	1	PR		P		
MOUNTAIN BROOK LAMPREY	Ichthyomyzon greeleyi	1	HB		P	S	
SILVER LAMPREY	Ichthyomyzon unicuspis	1	PR				
LEAST BROOK LAMPREY	Lampetra aepyptera	1	HB		P		
AMERICAN BROOK LAMPREY	Lampetra appendix	1	HB		P	S	
LAKE STURGEON	Acipenser fulvescens	1	IN	L	P	S	
PALLID STURGEON	Scaphirhynchus albus	1	IN		P	S	
SHOVELNOSE STURGEON	Scaphirhynchus platorynchus	1	IN	L	P	S	
PADDLEFISH	Polyodon spathula	1	PK	L	P		
SPOTTED GAR	Lepisosteus oculatus	1	PS		P		
LONGNOSE GAR	Lepisosteus osseus	1	PS		P		TO
SHORTNOSE GAR	Lepisosteus platostomus	1	PS		P		
ALLIGATOR GAR	Lepisosteus spatula	1	PS		P		
BOWFIN	Amia calva	1	PS		P		TO
GOLDEYE	Hiodon alosoides	1	IN	L	P		
MOONEYE	Hiodon tergisus	1	IN	L	P	S	
AMERICAN EEL	Anguilla rostrata	1	PS		P		
ALABAMA SHAD	Alosa alabamae	1	OM				
SKIPJACK HERRING	Alosa chrysochloris	1	PS		P	S	
ALEWIFE	Alosa pseudoharengus	.	PK				
GIZZARD SHAD	Dorosoma cepedianum	1	OM		P		TO
THREADFIN SHAD	Dorosoma petenense	1	HB		P		
CENTRAL STONEROLLER	Campostoma anomalum	1	OM				
GOLDFISH	Carassius auratus	.	OM				TO
ROSYSIDE DACE	Clinostomus funduloides	1	SP	L	P	S	
GRASS CARP	Ctenopharyngodon idella	.	HB				
BLUNTFACE SHINER	Cyprinella camura	1	IN		P		
WHITETAIL SHINER	Cyprinella galactura	1	IN		P		
RED SHINER	Cyprinella lutrensis	1	IN				
SPOTFIN CHUB	Cyprinella monacha	1	SP		R	S	
SPOTFIN SHINER	Cyprinella spiloptera	1	IN		P		TO
BLACKTAIL SHINER	Cyprinella venusta		IN		P		
STEELCOLOR SHINER	Cyprinella whipplei	1	IN		P		
COMMON CARP	Cyprinus carpio	.	OM				TO
SLENDER CHUB	Erimystax cahni	1	SP	L	R	S	
STREAMLINE CHUB	Erimystax dissimilis	1	SP	L	R	S	INT

BLOPSHED CHUB	Erimystax insignis	1	OM	L	R		
FLAME CHUB	Hemitremia flammea	1	IN	L	P		
CYPRESS MINNOW	Hybognathus hayi	1	OM		P		
MISSISSIPPI SILVERY MINNOW	Hybognathus nuchalis	1	OM		P		
SILVER CARP	Hypophthalmichthys molitrix	.	PK				
STRIPED SHINER	Luxilus chrysocephalus	1	OM	L	P		TO
WARPAINT SHINER	Luxilus coccogenis	1	SP	L	P	S	
ROSEFIN SHINER	Lythrurus ardens	1	SP	L	P		
RIBBON SHINER	Lythrurus fumeus	1	SP	L	P		TO
MOUNTAIN SHINER	Lythrurus lirus	1	SP	L	P	S	
REDFIN SHINER	Lythrurus umbratilis	1	SP	L	P		
SPECKLED CHUB	Macrhybopsis aestivalis	1	SP	L	R	S	
SILVER CHUB	Macrhybopsis storeriana	1	SP	L	P	S	
REDTAIL CHUB	Nocomis effusus	1	OM		P		
BLUEHEAD CHUB	Nocomis leptocephalus	1	OM		P		
RIVER CHUB	Nocomis micropogon	1	OM		P		
GOLDEN SHINER	Notemigonus crysoleucas	1	OM		P		TO
SAWFIN SHINER	Notropis (undescribed)	1	SP	L	R	S	
BIGEYE CHUB	Notropis amblops	1	SP	L	P	S	
PALEZONE SHINER	Notropis (undescribed)	1	SP	L	P	S	
PALLID SHINER	Notropis amnis	1	SP	L			
POPEYE SHINER	Notropis ariommus	1	SP	L	P	S	INT
EMERALD SHINER	Notropis atherinoides	1	SP	L	P		
RIVER SHINER	Notropis blennius	1	OM	L	P		
BIGEYE SHINER	Notropis boops	1	SP	L	P	S	INT
GHOST SHINER	Notropis buchanani	1	SP	L	P		
RAINBOW SHINER	Notropis chrosomus	1	SP	L			
TENNESSEE SHINER	Notropis leuciodus	1	SP	L	P	S	
YELLOWFIN SHINER	Notropis lutipinnis		SP	L			
SILVER SHINER	Notropis photogenis	1	SP	L	P		
ROSYFACE SHINER	Notropis rubellus	1	SP	L	P		
SAFFRON SHINER	Notropis rubricroceus	1	SP	L	P	S	
SILVERBAND SHINER	Notropis shumardi	1	SP	L			
MIRROR SHINER	Notropis spectrunculus	1	SP	L	P		
SAND SHINER	Notropis stramineus	1	SP	L	P		
TELESCOPE SHINER	Notropis telescopus	1	SP	L	P	S	INT
WEED SHINER	Notropis texanus	.	SP				
MIMIC SHINER	Notropis volucellus	1	SP	L	P		
CHANNEL SHINER	Notropis wickliffi	1	SP	L	P		
HYBRID SHINER	Hybrid notropis	1	IN				
PUGNOSE MINNOW	Opsopoeodus emiliae	1	SP		P		
FATLIPS MINNOW	Phenacobius crassilabrum	1	SP	L	R		
SUCKERMOUTH MINNOW	Phenacobius mirabilis	1	SP	L	R		
STARGAZING MINNOW	Phenacobius uranops	1	SP	L	R		
SOUTHERN REDBELLY DACE	Phoxinus erythrogaster	1	HB	L	P	S	
TENNESSEE DACE	Phoxinus tennesseensis	1	HB	L	P	S	
BLUNTNOSE MINNOW	Pimephales notatus	1	OM		P		
FATHEAD MINNOW	Pimephales promelas	.	OM		P		
BULLHEAD MINNOW	Pimephales vigilax	1	SP		P		
BLACKNOSE DACE	Rhinichthys atratulus	1	IN	L			
LONGNOSE DACE	Rhinichthys cataractae	1	SP	L	R	S	

CREEK CHUB	Semotilus atromaculatus	1	IN		P		TO
RIVER CARPSUCKER	Carpiodes carpio	1	OM		P		
QUILLBACK	Carpiodes cyprinus	1	OM		P		
HIGHFIN CARPSUCKER	Carpiodes velifer	1	OM		P		
WHITE SUCKER	Catostomus commersoni	1	OM	L	P		TO
BLUE SUCKER	Cycleptus elongatus	1	IN	L	P	S	
CREEK CHUBSUCKER	Erimyzon oblongus	1	IN	L	P	S	INT
LAKE CHUBSUCKER	Erimyzon sucetta	1	IN				
ALABAMA HOG SUCKER	Hypentelium etowanum	.	IN				
NORTHERN HOG SUCKER	Hypentelium nigricans	1	IN	L		S	
SMALLMOUTH BUFFALO	Ictiobus bubalus	1	OM		P		
BIGMOUTH BUFFALO	Ictiobus cyprinellus	1	PK		P		
BLACK BUFFALO	Ictiobus niger	1	OM		P		
SPOTTED SUCKER	Minytrema melanops	1	IN	L	P		
SILVER REDHORSE	Moxostoma anisurum	1	IN	L	P		
RIVER REDHORSE	Moxostoma carinatum	1	IN	L	P		
BLACK REDHORSE	Moxostoma duquesnei	1	IN	L	P	S	INT
GOLDEN REDHORSE	Moxostoma erythrurum	1	IN	L	P		
SHORTHEAD REDHORSE	Moxostoma macrolepidotum	1	IN	L	P		
(UNDESCRIBED) REDHORSE	Moxostoma (undescribed)	1	IN	L	P		
WHITE CATFISH	Ameiurus catus	.	OM		P		
BLACK BULLHEAD	Ameiurus melas	1	OM		P		TO
YELLOW BULLHEAD	Ameiurus natalis	1	OM		P		TO
BROWN BULLHEAD	Ameiurus nebulosus	1	OM		P		TO
FLAT BULLHEAD	Ameiurus platycephalus	.	IN				
SNAIL BULLHEAD	Ameiurus brunneus	.	IN				
BLUE CATFISH	Ictalurus furcatus	1	OM		P		
CHANNEL CATFISH	Ictalurus punctatus	1	OM		P		
SMOKY MADTOM	Noturus baileyi	1	SP		R	S	
ELEGANT MADTOM	Noturus elegans	1	SP		R	S	INT
MOUNTAIN MADTOM	Noturus eleutherus	1	SP		R	S	INT
SLENDER MADTOM	Noturus exilis	1	SP		P	S	INT
YELLOWFIN MADTOM	Noturus flavipinnis	1	SP		P	S	
STONECAT	Noturus flavus	1	SP		P	S	
TADPOLE MADTOM	Noturus gyrinus	1	SP		P	S	
MARGINED MADTOM	Noturus insignis	.	SP				
BRINDLED MADTOM	Noturus miurus	1	SP		P	S	INT
FRECKLED MADTOM	Noturus nocturnus	1	SP				
PYGMY MADTOM	Noturus stanauli	1	SP		R	S	
FLATHEAD CATFISH	Pylodictis olivaris	1	PS		P		
GRASS PICKEREL	Esox americanus vermicalutus	1	PS		P		
NORTHERN PIKE	Esox lucius	.	PS				
MUSKELLUNGE	Esox masquinongy	1	PS		P		
CHAIN PICKEREL	Esox niger	1	PS		P		
CENTRAL MUDMINNOW	Umbra limi	1	IN		P		
RAINBOW TROUT	Oncorhynchus mykiss	.	IN				
BROWN TROUT	Salmo trutta	.	PS				
BROOK TROUT	Salvelinus fontinalis	1	IN		P	S	INT
LAKE TROUT	Salvelinus namaycush	.	IN				
PIRATE PERCH	Aphredoderus sayanus	1	IN		P		
SPRING CAVEFISH	Chologaster agassizi	1	IN				

ALABAMA CAVEFISH	Speoplatyrhinus poulsoni	1	IN				
SOUTHERN CAVEFISH	Typhlichthys subterraneus	1	IN				
ATLANTIC NEEDLEFISH	Strongylura marina	.	PS				
NORTHERN STUDFISH	Fundulus catenatus	1	SP	L	R	S	
STARHEAD TOPMINNOW	Fundulus dispar	1	IN				
BLACKSTRIPE TOPMINNOW	Fundulus notatus	1	IN		P		
BLACKSPOTTED TOPMINNOW	Fundulus olivaceus	1	IN		P		
WESTERN MOSQUITOFISH	Gambusia affinis	0	IN		P		TO
BROOK SILVERSIDE	Labidesthes sicculus	1	IN		P		
INLAND SILVERSIDE	Menidia beryllina	1	IN				
BROOK STICKLEBACK	Culaea inconstans	.	IN				
BLACK SCULPIN	Cottus baileyi	1	IN		R		
MOTTLED SCULPIN	Cottus bairdi	1	IN		R		
BANDED SCULPIN	Cottus carolinae	1	IN		R		
HOLSTON SCULPINS	Cottus (undescribed)	1	IN		R		
BLACK AND HOLSTON SCULPINS	Cottus spp.	2	IN		R		
WHITE BASS	Morone chrysops	1	PS	L	P		
YELLOW BASS	Morone mississippiensis	1	PS	L	P		
STRIPED BASS	Morone saxatilis	.	PS				
HYBRID STRIPED X WHITE BASS	Hybrid morone (chrysops x sax)	1	PS				
HYBRID WHITE X YELLOW BASS	Hybrid morone (chrysops x miss	1	PS				
ROCK BASS	Ambloplites rupestris	1	PS		P	S	
ROCK BASS	Ambloplites rupestris > 5" TL	1	PS		P	S	INT
FLIER	Centrarchus macropterus	1	IN				
BANDED PYGMY SUNFISH	Elassoma zonatum	1	IN				
REDBREAST SUNFISH	Lepomis auritus	.	IN				
GREEN SUNFISH	Lepomis cyanellus	1	IN		P		TO
PUMPKINSEED	Lepomis gibbosus	.	IN				
WARMOUTH	Lepomis gulosus	1	IN		P		
ORANGESPOTTED SUNFISH	Lepomis humilis	1	IN		P		
BLUEGILL	Lepomis macrochirus	1	IN		P		
DOLLAR SUNFISH	Lepomis marginatus	1	IN		P	S	
LONGEAR SUNFISH	Lepomis megalotis	1	IN		P	S	
REDEAR SUNFISH	Lepomis microlophus	1	IN		P		
SPOTTED SUNFISH	Lepomis punctatus	1	IN		P		
HYBRID SUNFISH	Hybrid Lepomis sp.	1	IN				
HYBRID BASS	Hybrid Micropterus sp.		PS				
REDEYE BASS	Micropterus coosae	.	PS		P		
SMALLMOUTH BASS	Micropterus dolomieu	1	PS		P		
SPOTTED BASS	Micropterus punctulatus	1	PS		P		
LARGEMOUTH BASS	Micropterus salmoides	1	PS		P		
WHITE CRAPPIE	Pomoxis annularis	1	PS		P		
BLACK CRAPPIE	Pomoxis nigromaculatus	1	PS		P		
NAKED SAND DARTER	Ammocrypta beani	1	SP	L	P	S	
WESTERN SAND DARTER	Ammocrypta clara	1	SP	L	P	S	
EASTERN SAND DARTER	Ammocrypta pellucida	1	SP	L	P	S	
SCALY SAND DARTER	Ammocrypta vivax	1	SP	L	P	S	
DUSKYTAIL DARTER	Etheostoma (undescribed)	1	SP		P	S	
SHARPHEAD DARTER	Etheostoma acuticeps	1	SP	L	R		
COPPERCHEEK DARTER	Etheostoma aquali	1	SP		R	S	
MUD DARTER	Etheostoma asprigene	1	SP	L	P		

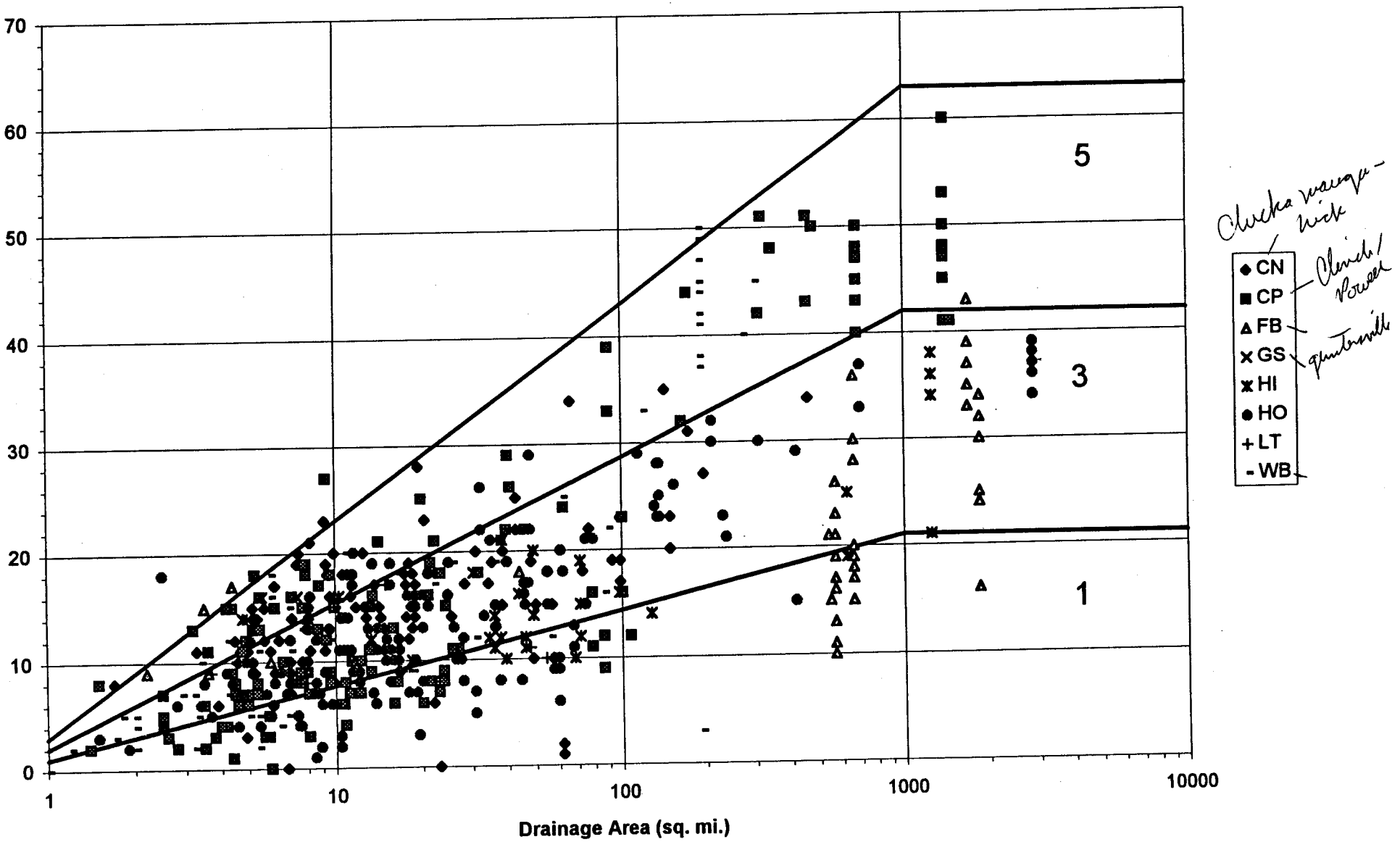
GREENSIDE DARTER	Etheostoma blennioides	1 SP	L	R		
BLENNY DARTER	Etheostoma blennius	1 SP	L	R	S	
RAINBOW DARTER	Etheostoma caeruleum	1 SP	L	R		
BLUEBREAST DARTER	Etheostoma camurum	1 SP	L	R	S	INT
GREENFIN DARTER	Etheostoma chlorobranchium	1 SP	L	P		
BLUNTNOSE DARTER	Etheostoma chlorosomum	1 SP	L	P	S	INT
ASHY DARTER	Etheostoma cinereum	1 SP	L	P	S	
FRINGED DARTER	Etheostoma crossopterum	1 SP		P		
BLACK DARTER	Etheostoma duryi	1 SP	L	R	S	
FANTAIL DARTER	Etheostoma flabellare	1 SP		R	S	INT
SAFFRON DARTER	Etheostoma flavum	1 SP	L	R	S	
SWAMP DARTER	Etheostoma fusiforme	SP		P		
SLOUGH DARTER	Etheostoma gracile	1 SP		P		
HARLEQUIN DARTER	Etheostoma histrio	1 SP	L	R		
BLUESIDE DARTER	Etheostoma jessiae	1 SP	L	P	S	INT
STRIPETAIL DARTER	Etheostoma kennicotti	1 SP	L	P		
REDBAND DARTER	Etheostoma luteovinctum	1 SP	L			
BRIGHTEYE DARTER	Etheostoma lynceum	1 SP	L	R		
LOLLIPOP DARTER	Etheostoma neopterum	1 SP		R		
BLACKFIN DARTER	Etheostoma nigripinne	1 SP		P		
JOHNNY DARTER	Etheostoma nigrum	1 SP	L	P		
GOLDSTRIPE DARTER	Etheostoma parvipinne	1 SP	L	P		
CYPRESS DARTER	Etheostoma proeliare	1 SP	L	P		
REDLINE DARTER	Etheostoma rufilineatum	1 SP	L	R		
SNUBNOSE DARTER	Etheostoma simoterum	1 SP	L	R		
SLABROCK DARTER	Etheostoma smithi	1 SP		P		
ORANGETHROAT DARTER	Etheostoma spectabile	1 SP	L	R		
SPECKLED DARTER	Etheostoma stigmaeum	1 SP	L	P	S	INT
STRIATED DARTER	Etheostoma striatulum	1 SP		P	S	
GULF DARTER	Etheostoma swaini	1 SP	L	R		
SWANNANOA DARTER	Etheostoma swannanoa	1 SP	L	R	S	
TIPPECANOE DARTER	Etheostoma tippecanoe	1 SP	L	R	S	INT
TUSCUMBIA DARTER	Etheostoma tuscumbia	1 SP		P		
WOUNDED DARTER	Etheostoma vulneratum	1 SP		P	S	
BOULDER DARTER	Etheostoma wapiti	1 SP		P	S	
BANDED DARTER	Etheostoma zonale	1 SP	L	R		
BANDFIN DARTER	Etheostoma zonistium	1 SP	L	R		
SLACKWATER DARTER	Etheostoma boschungi	1 SP		P	S	
GUARDIAN DARTER	Etheostoma oophylax	1 SP		R		
HYBRID DARTER	Hybrid etheostoma	1 SP				
YELLOW PERCH	Perca flavescens	IN				
TANGERINE DARTER	Percina aurantiaca	1 SP	L		S	
BLOPSHSIDE LOGPERCH	Percina burtoni	1 SP	L	P	S	
LOGPERCH	Percina caprodes	1 SP	L	P		
CHANNEL DARTER	Percina copelandi	1 SP	L	P		
GILT DARTER	Percina evides	1 SP	L	R	S	INT
LONGHEAD DARTER	Percina macrocephala	1 SP	L	P	S	
BLACKSIDE DARTER	Percina maculata	1 SP	L	P		
SLENDERHEAD DARTER	Percina phoxocephala	1 SP	L	P	S	
DUSKY DARTER	Percina sciera	1 SP	L	P		
RIVER DARTER	Percina shumardi	1 SP	L	P		

OLIVE DARTER	Percina squamata	1 SP	L	R
SNAIL DARTER	Percina tanasi	1 SP	L	R
SADDLEBACK DARTER	Percina vigil	1 SP	L	R
HYBRID DARTER	Hybrid percina	1 SP		
SAUGER	Stizostedion canadense	1 PS	L	P
WALLEYE	Stizostedion vitreum	1 PS	L	P
HYBRID WALLEYE X SAUGER	Hybrid stizostedion	1 PS		
FRESHWATER DRUM	Aplodinotus grunniens	1 IN		P
STRIPED MULLET	Mugil cephalus	1 PK		

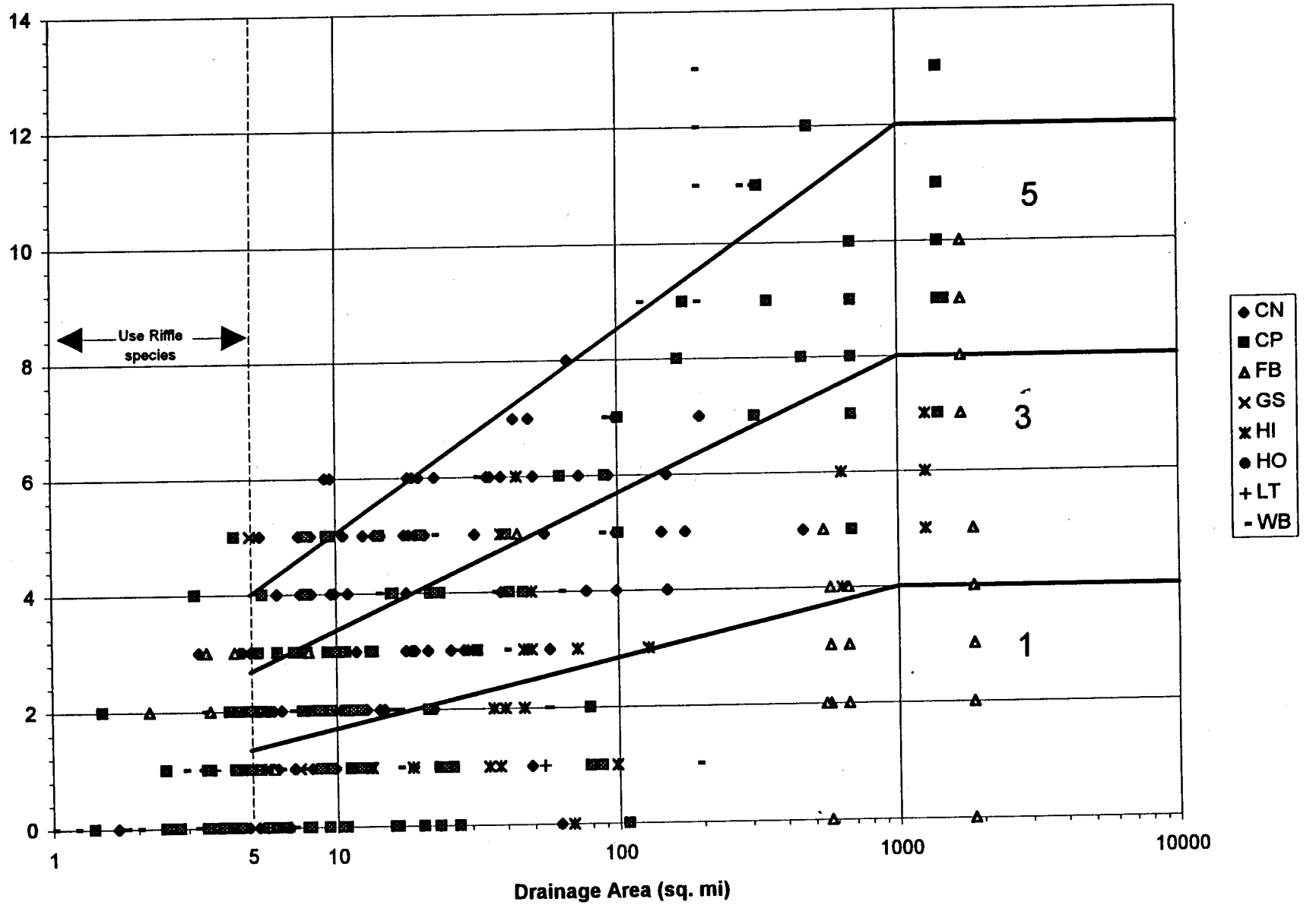
Explanation of abbreviations:HB=herbivore, IN=insectivore, INT=intolerant sp., OM=omnivore, PK=planktivore, PR=parasitic, SP=specialized insectivore, L=simple-lithophilic spawner, P=pool sp., R=riffle sp., S=sensative sp.,PS=Piscivore, TO=tolerant sp.

Figures 2a-2q. IBI metric scoring criteria delineated by trisection of data plots from 268 streams sites in the Blue Ridge Mountains Ecoregion (NC and TN).

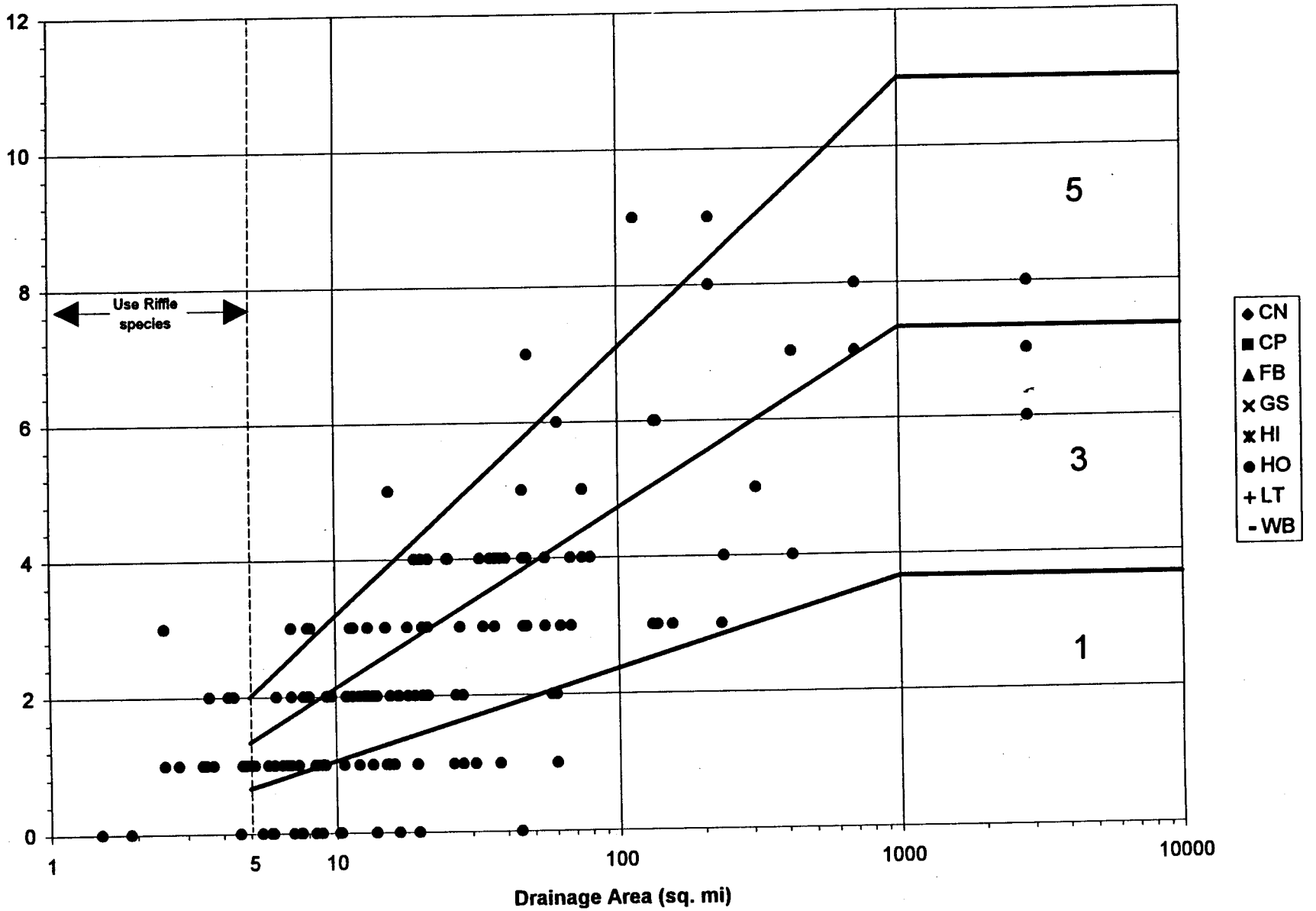
Ridge and Valley Ecoregion
No. Native Sps.



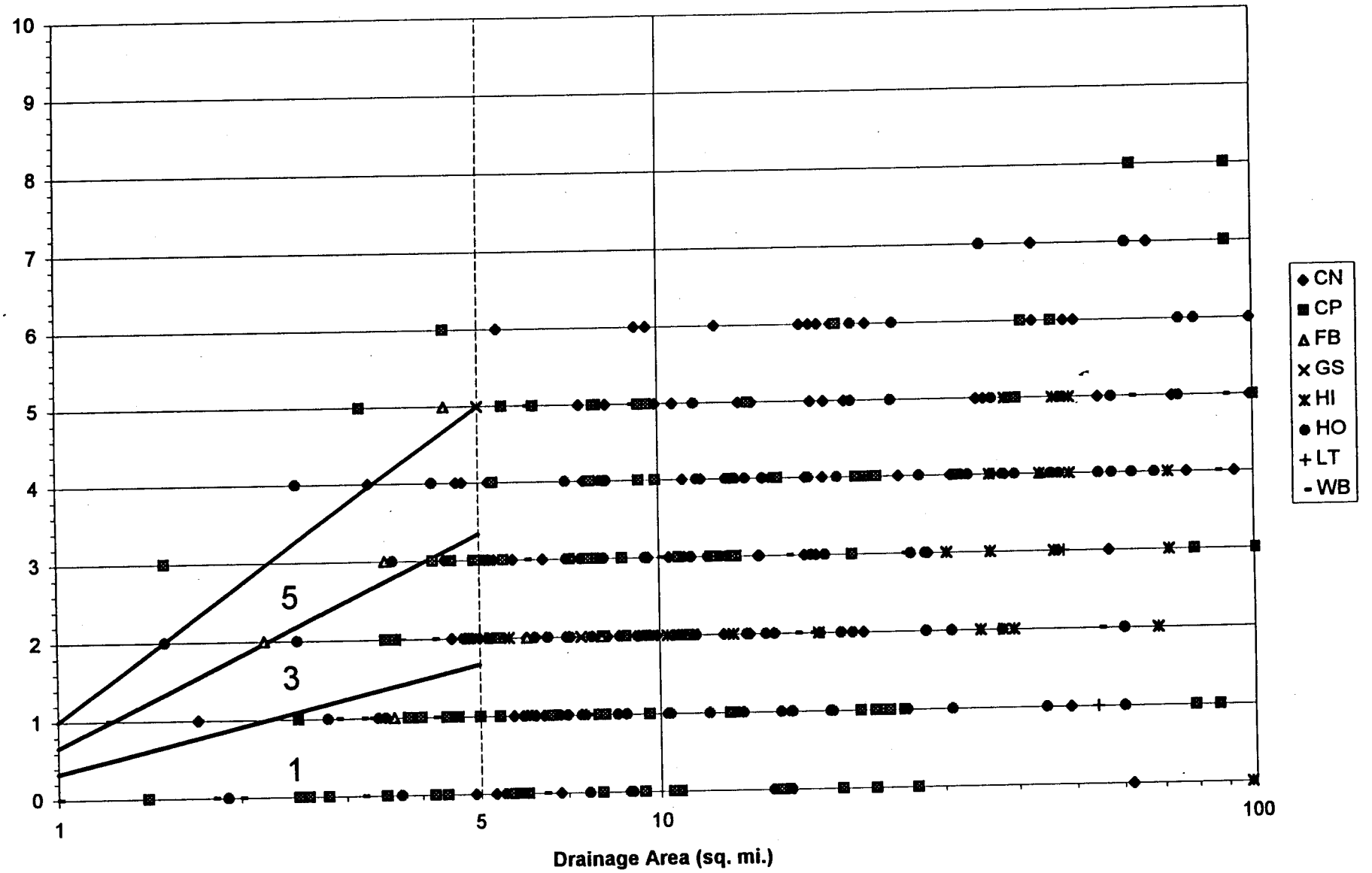
Ridge and Valley Ecoregion
No. Darter Sps. CP, CN, HI



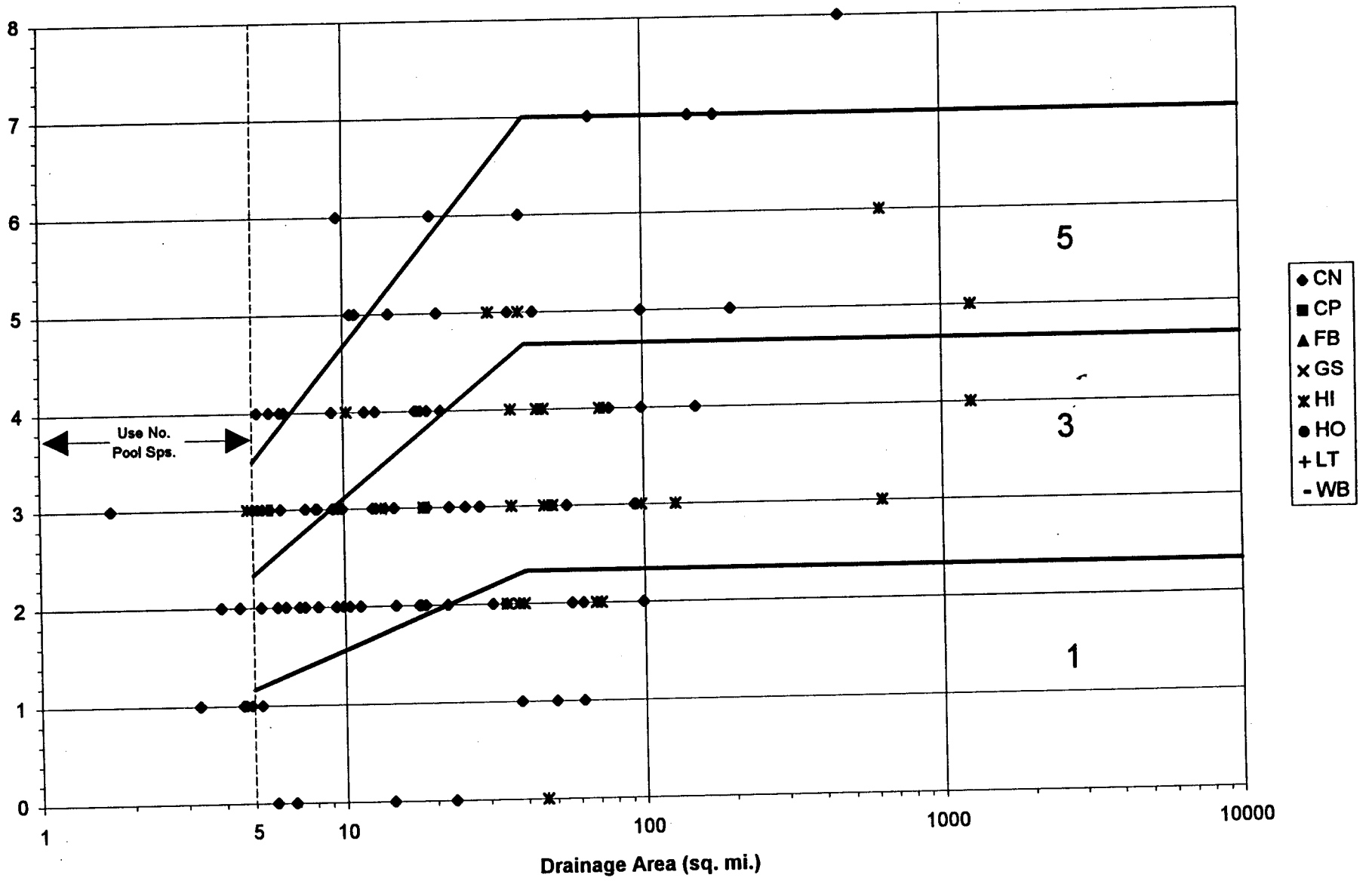
Ridge and Valley Ecoregion
No. Darter Sps. HO



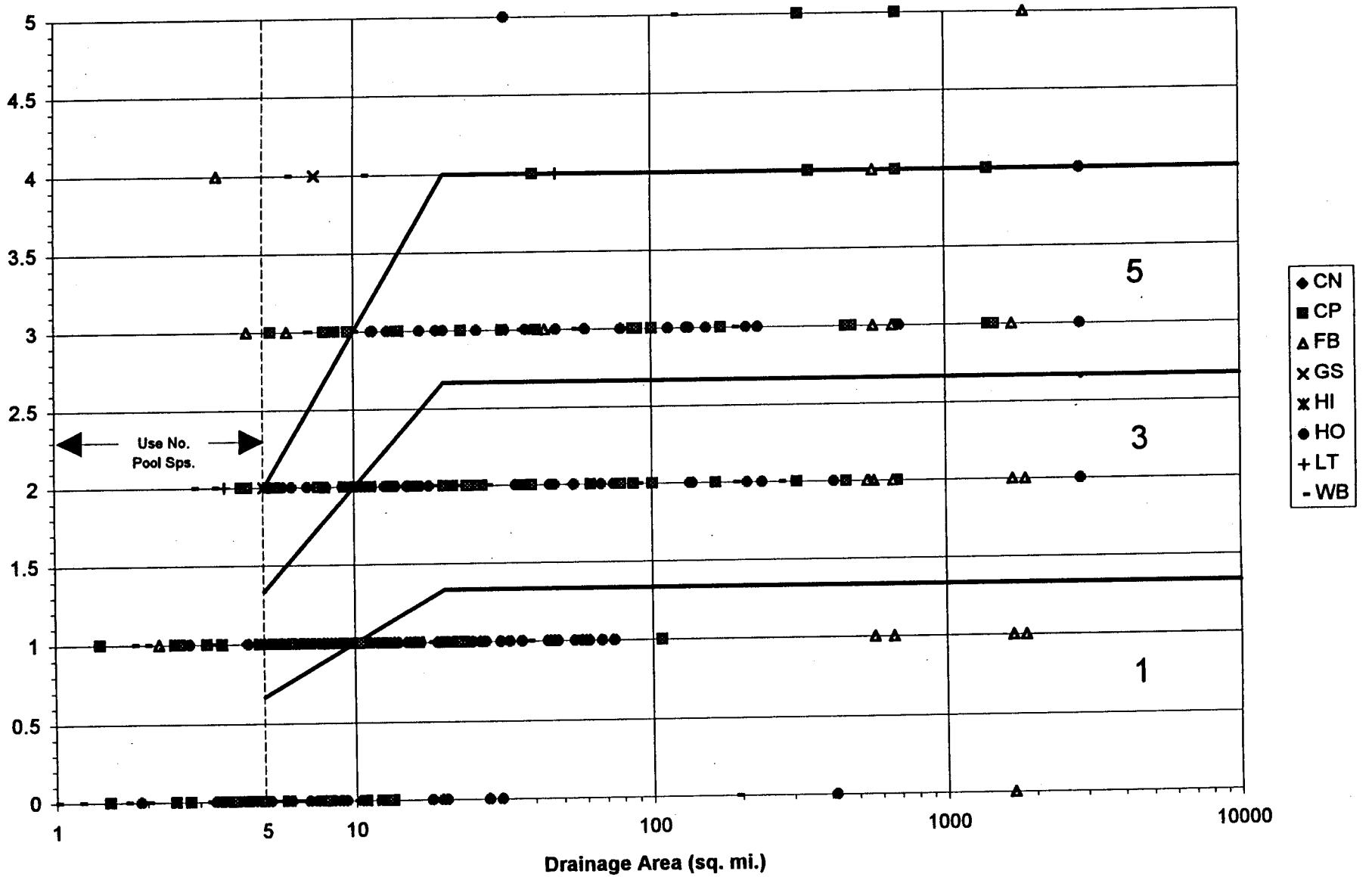
Ridge and Valley Ecoregion
No. Riffle Sps.



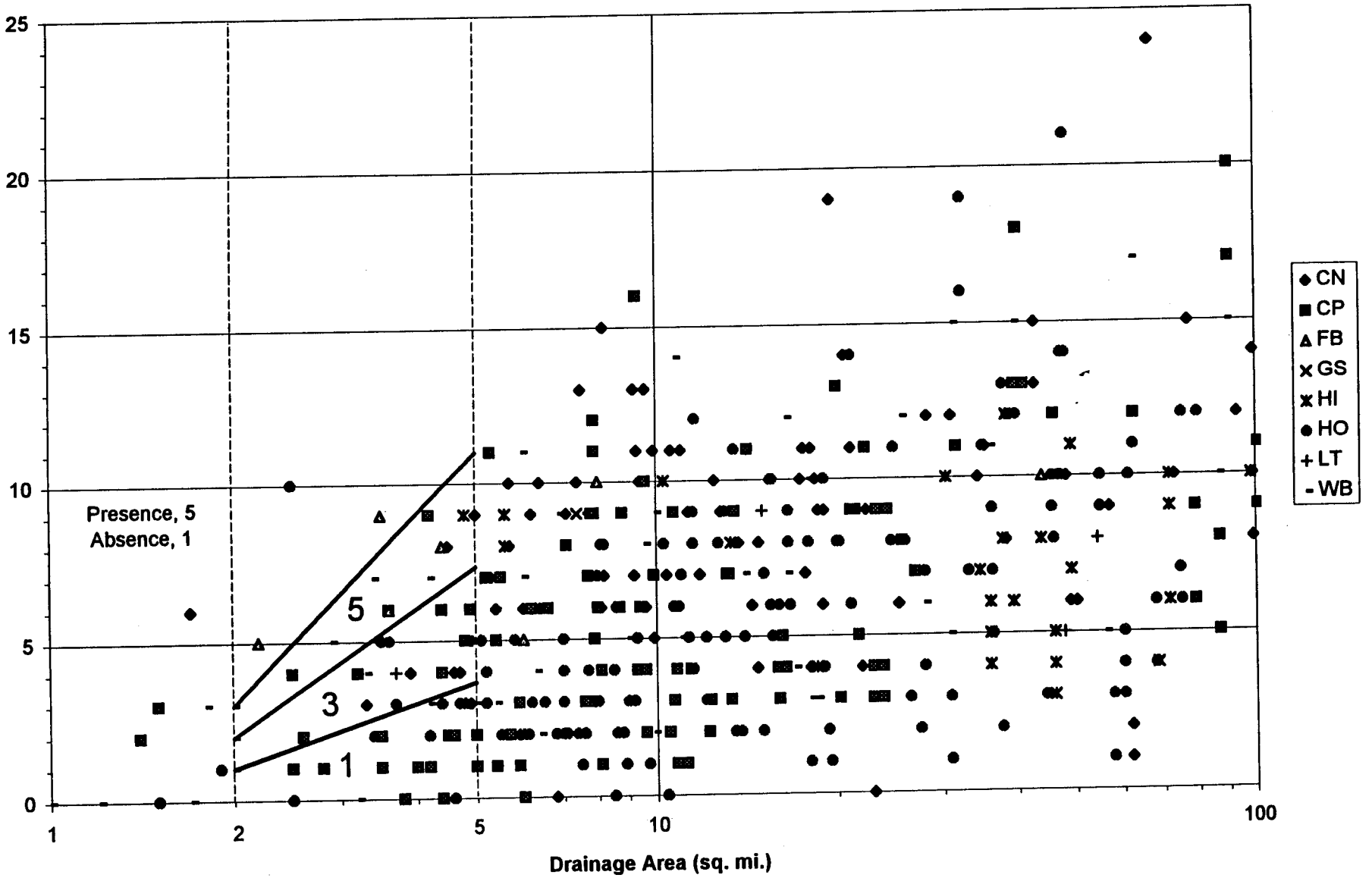
Ridge and Valley Ecoregion
No. Sunfish Sps. CN & HI



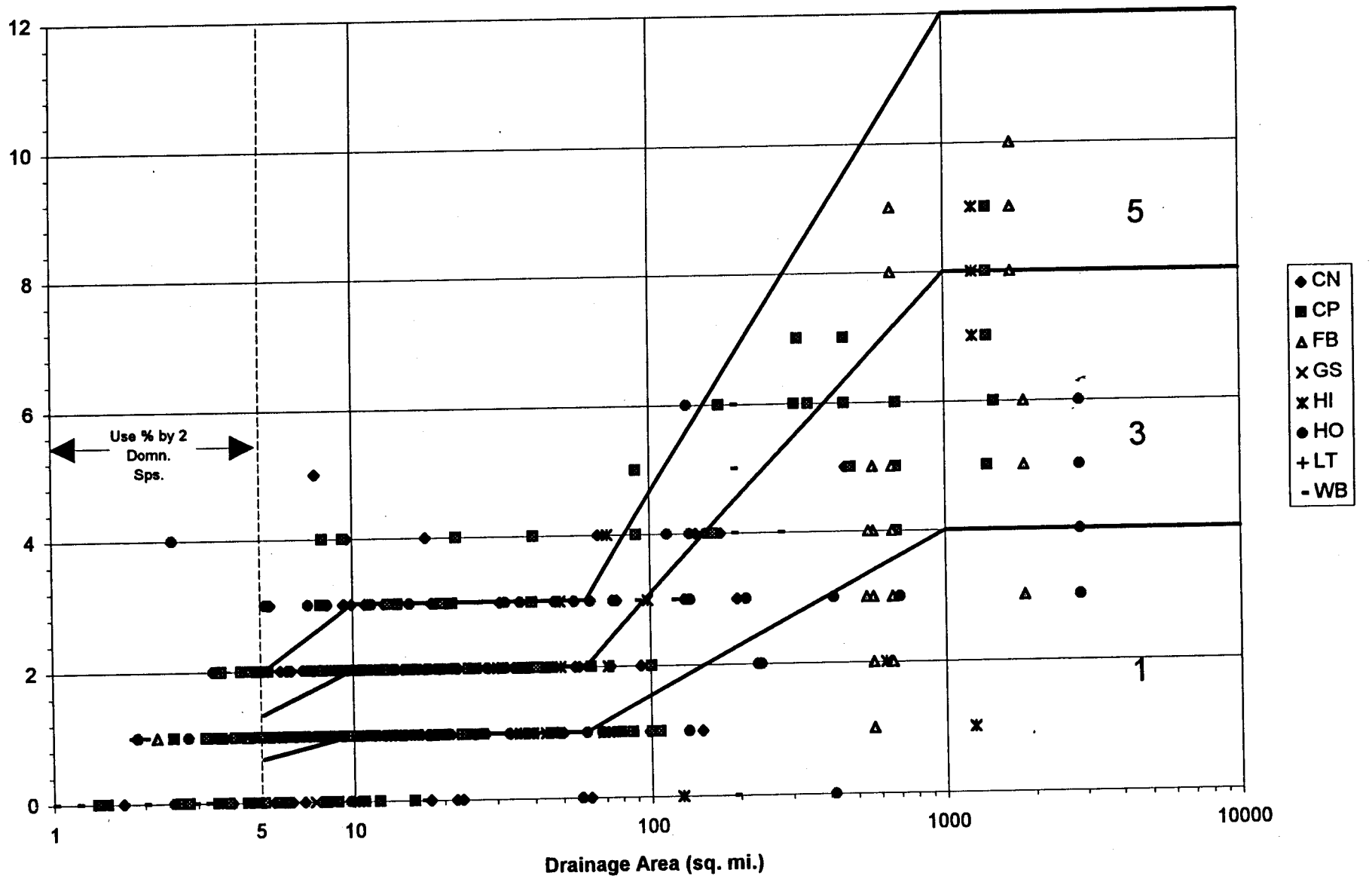
Ridge and Valley Ecoregion
No. Sunfish Sps. CP & HO



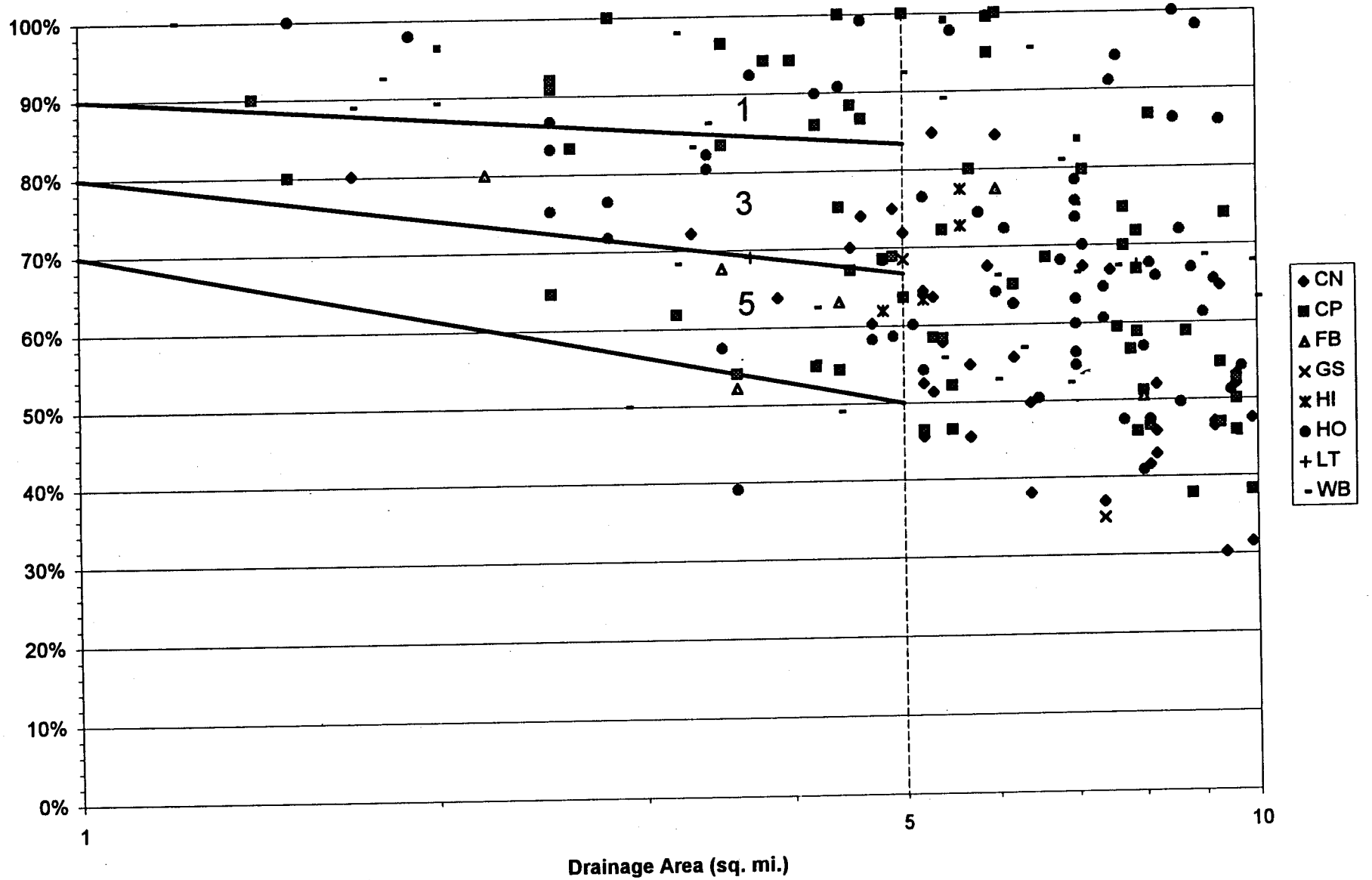
Ridge and Valley Ecoregion
No. Pool Sps.



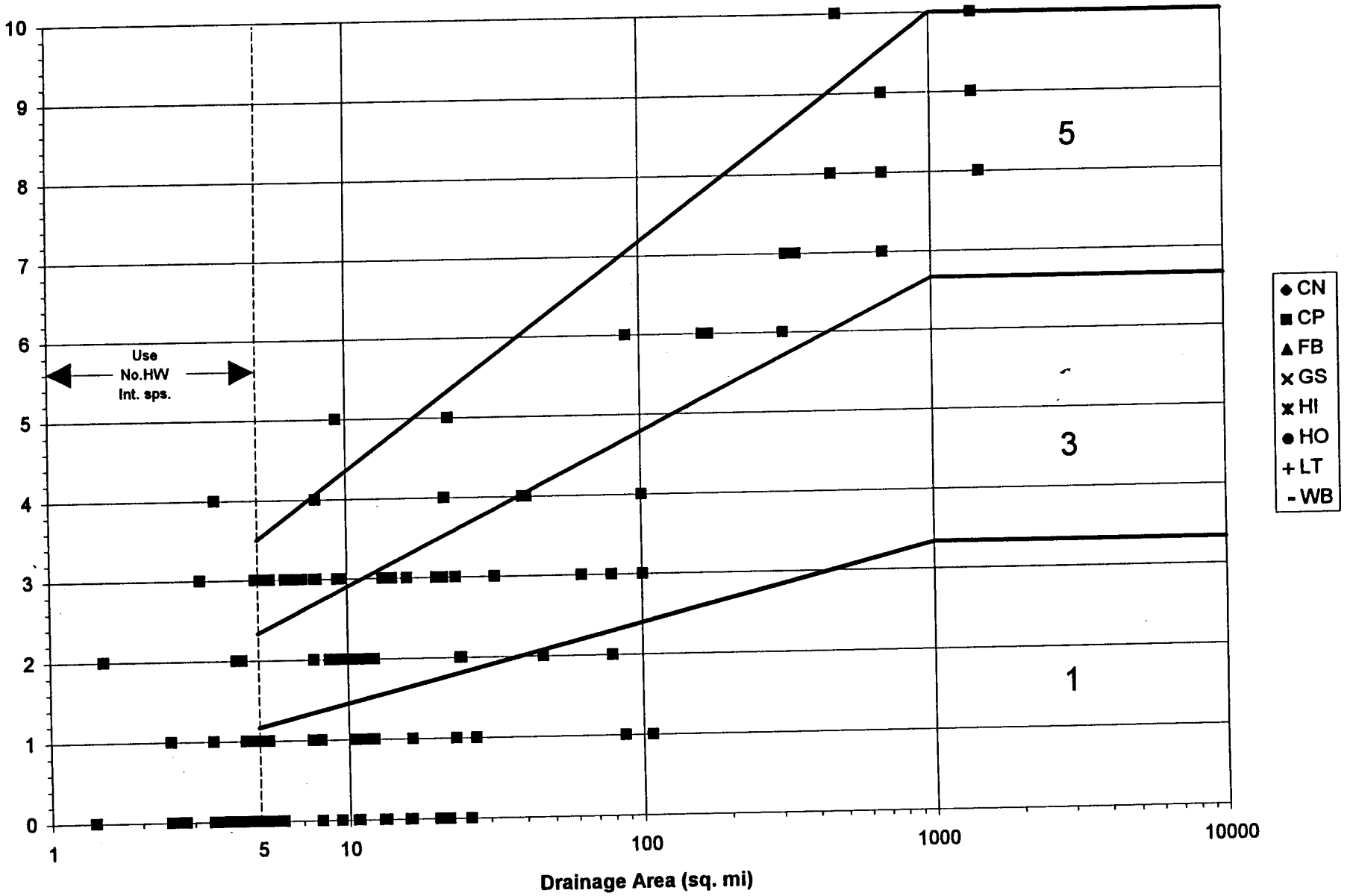
Ridge and Valley Ecoregion
No. Sucker Sps.



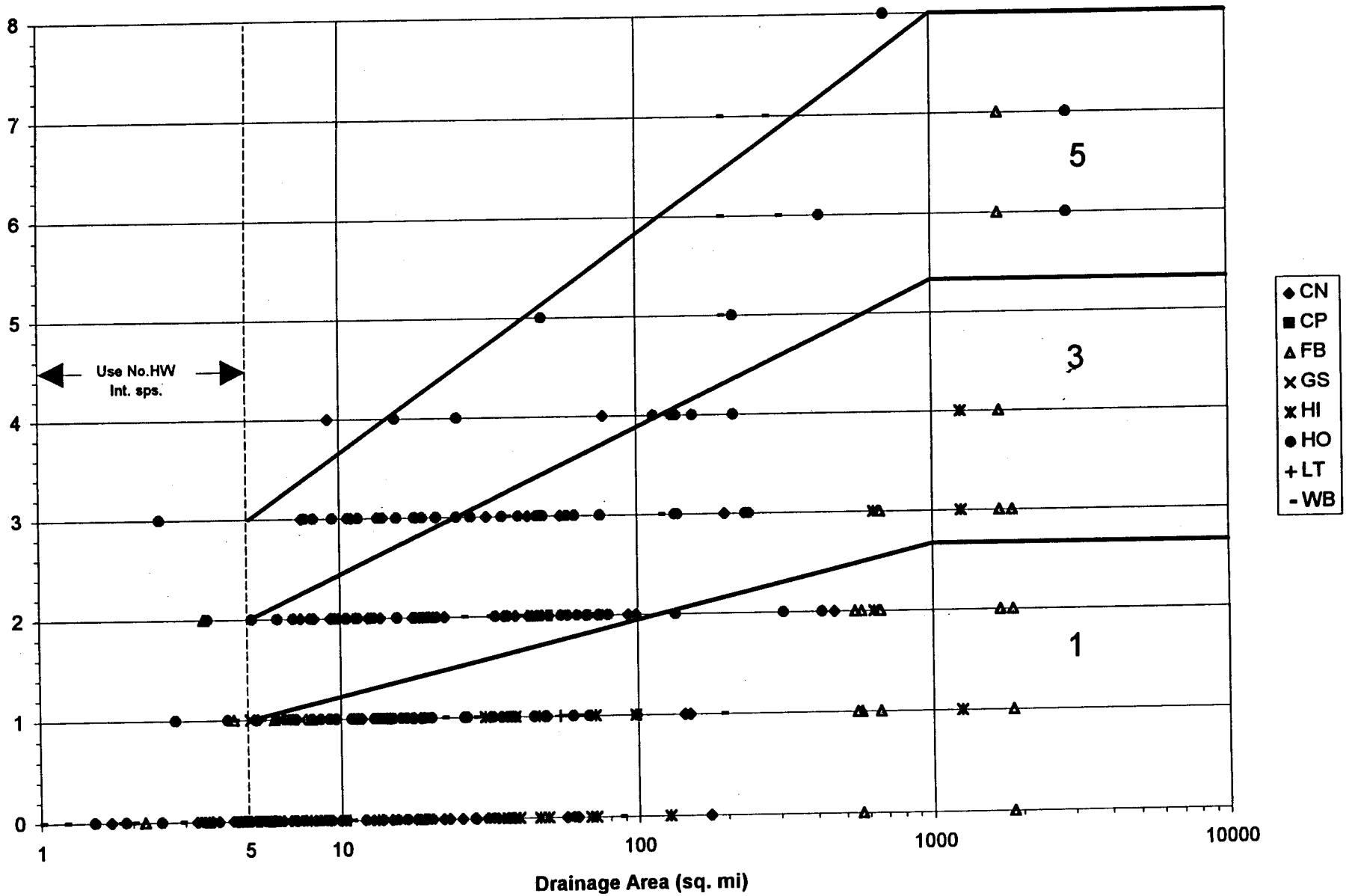
Ridge and Valley Ecoregion
% by 2 Domn. Sps.



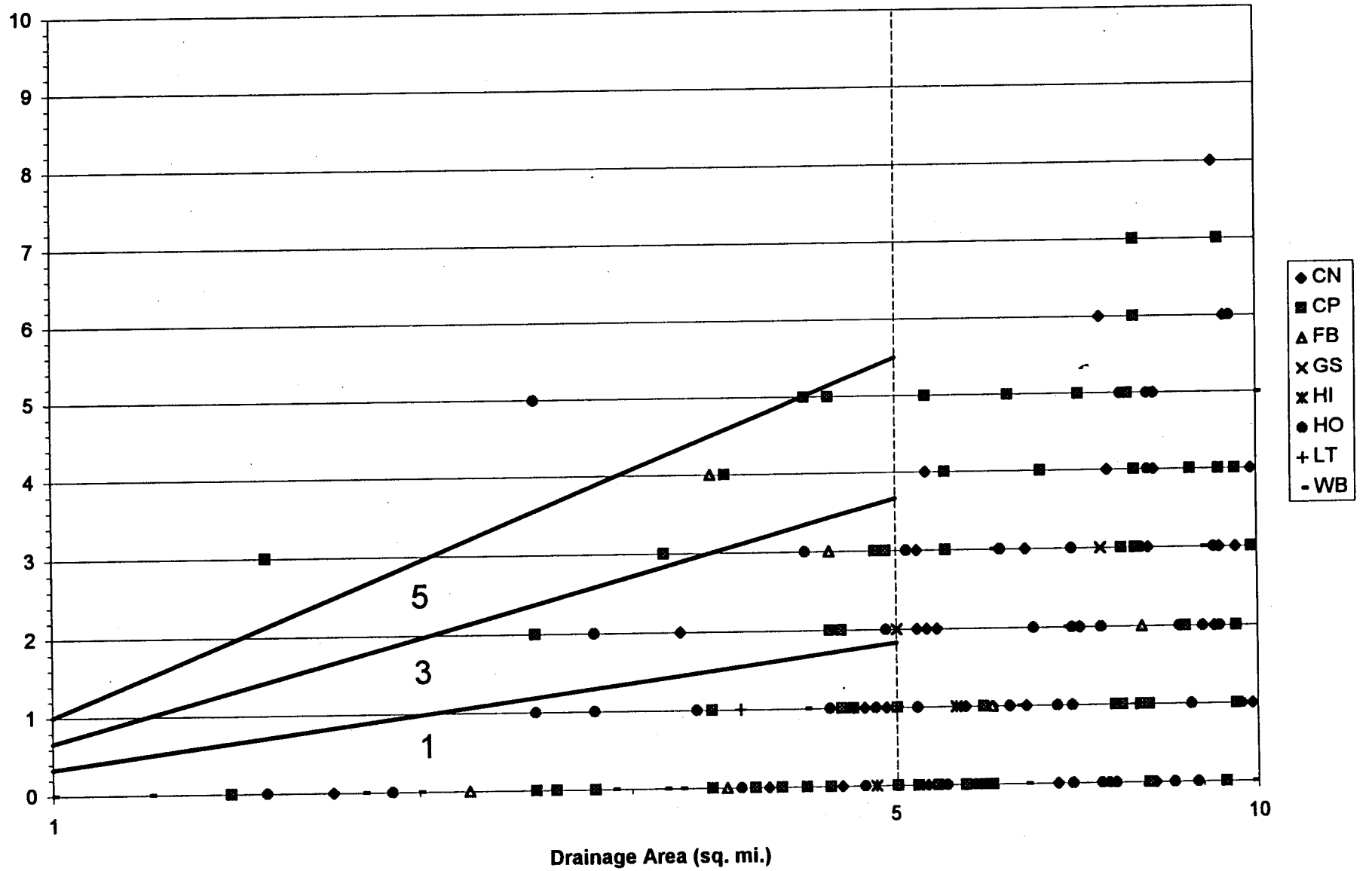
Ridge and Valley Ecoregion
No. Intol. Sps. CP



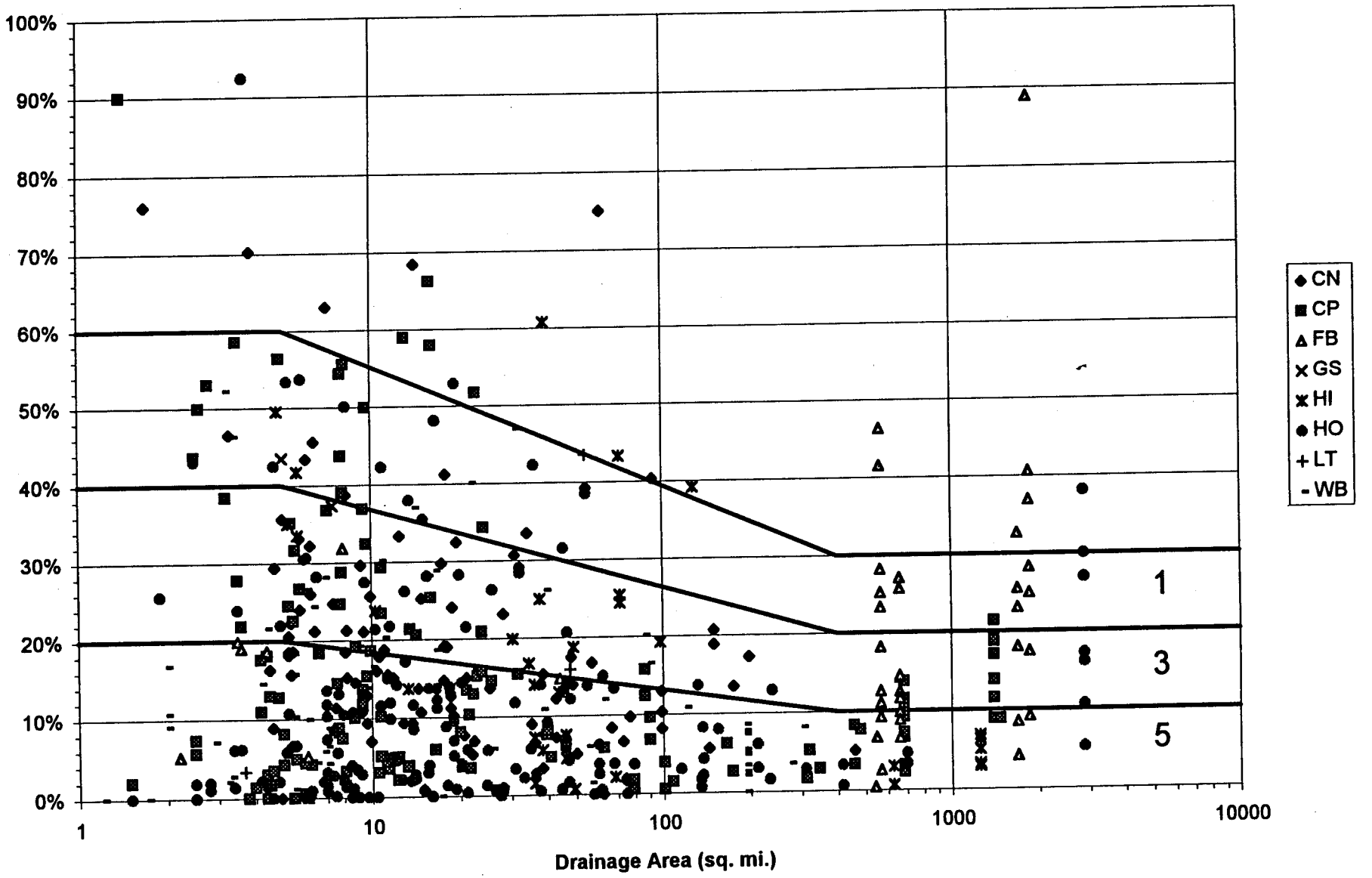
Ridge and Valley Ecoregion
No. Intol. Sps. CN, HI, HO



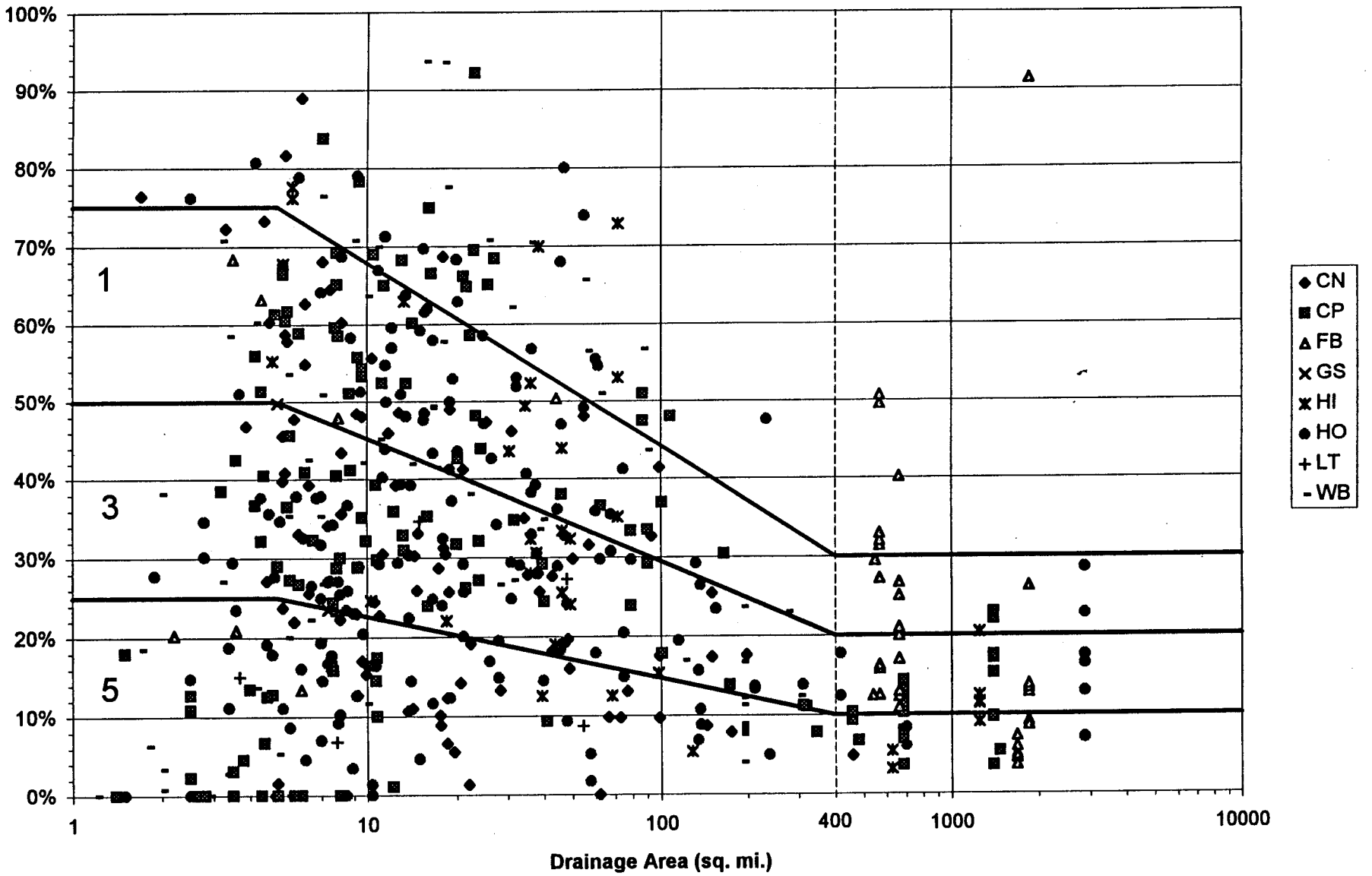
Ridge and Valley Ecoregion
No. HW Int. Sps.



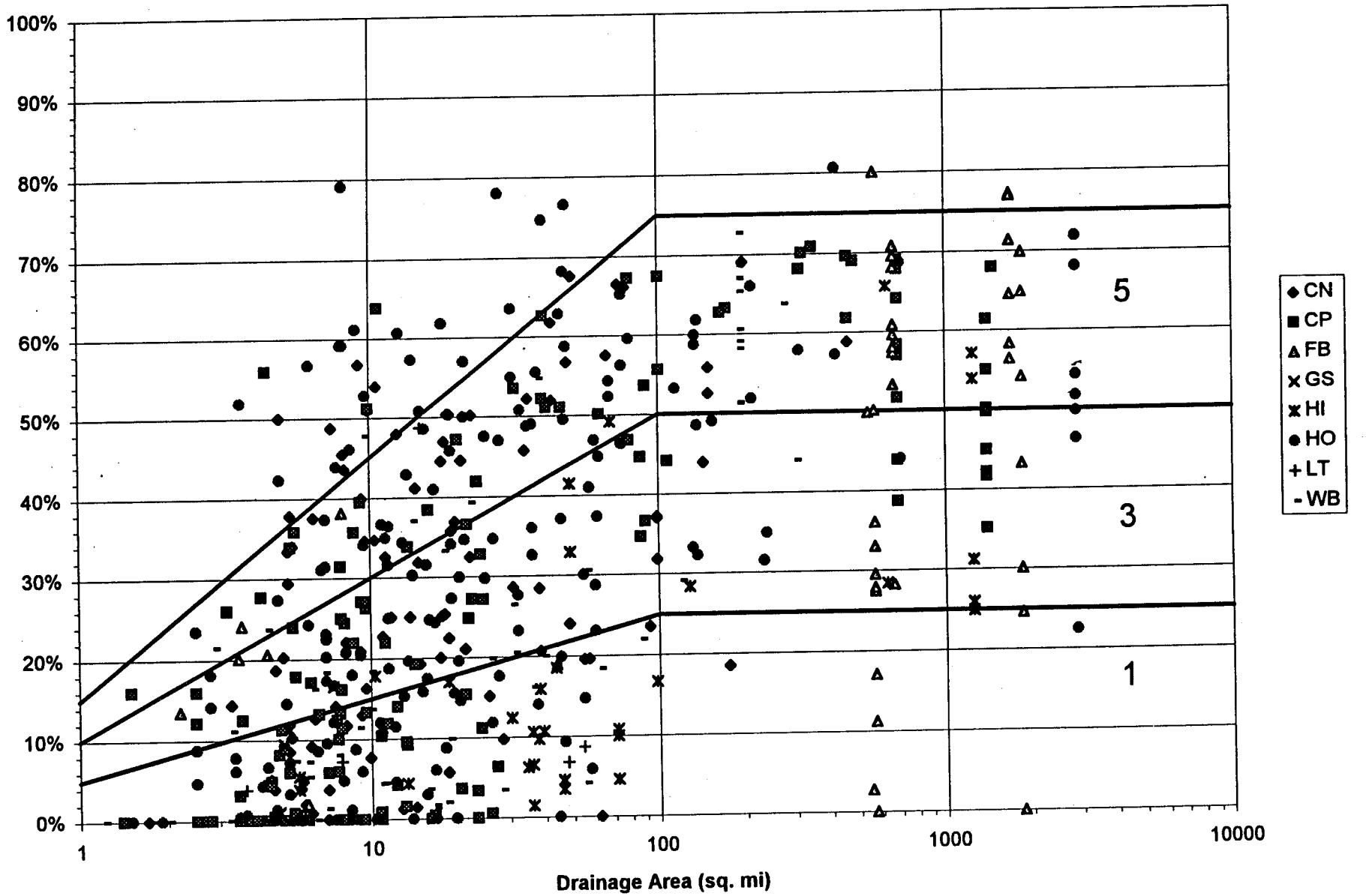
Ridge and Valley Ecoregion
% Tolerant Sps.



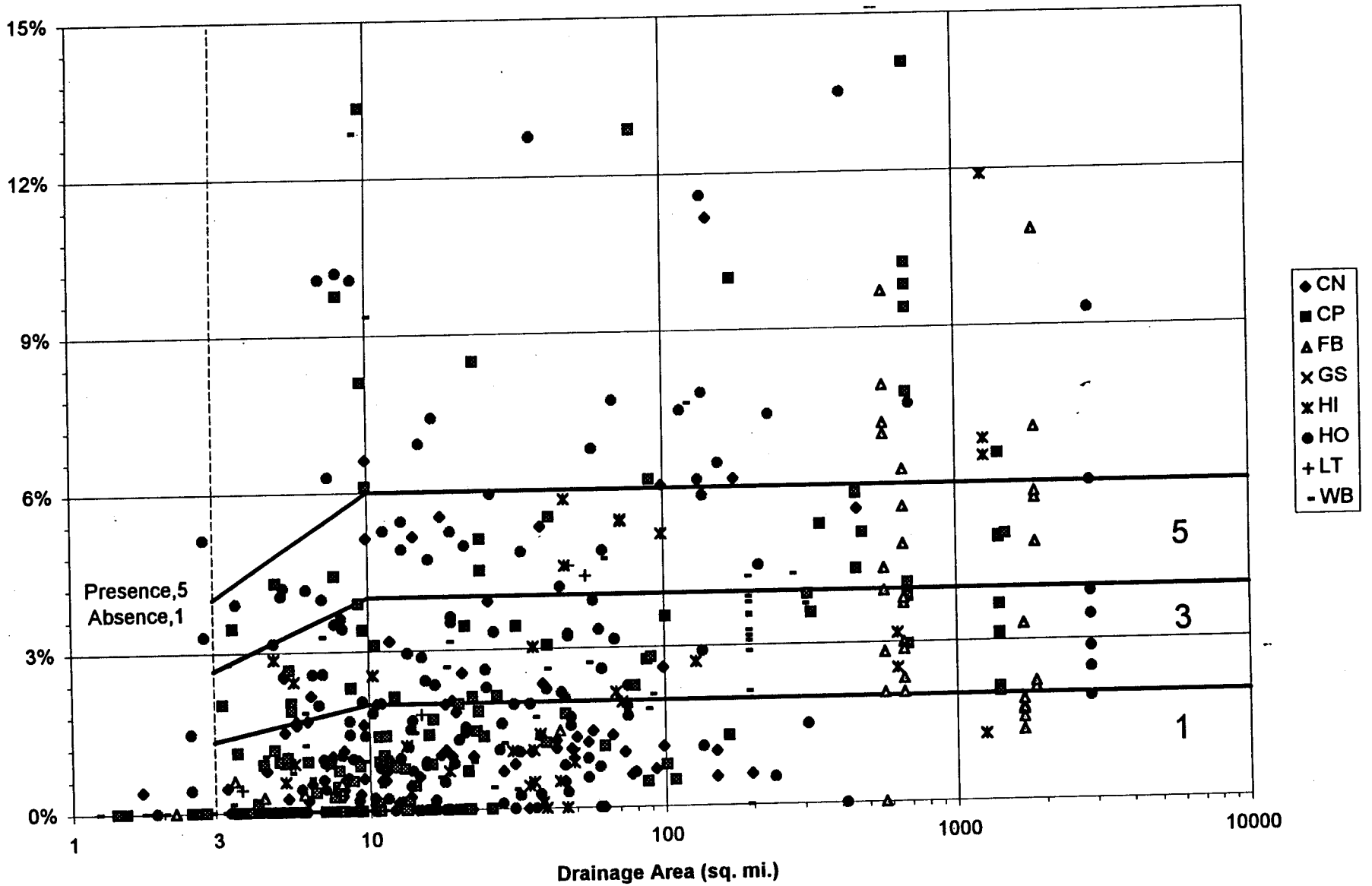
Ridge and Valley Ecoregion
% Omnivores



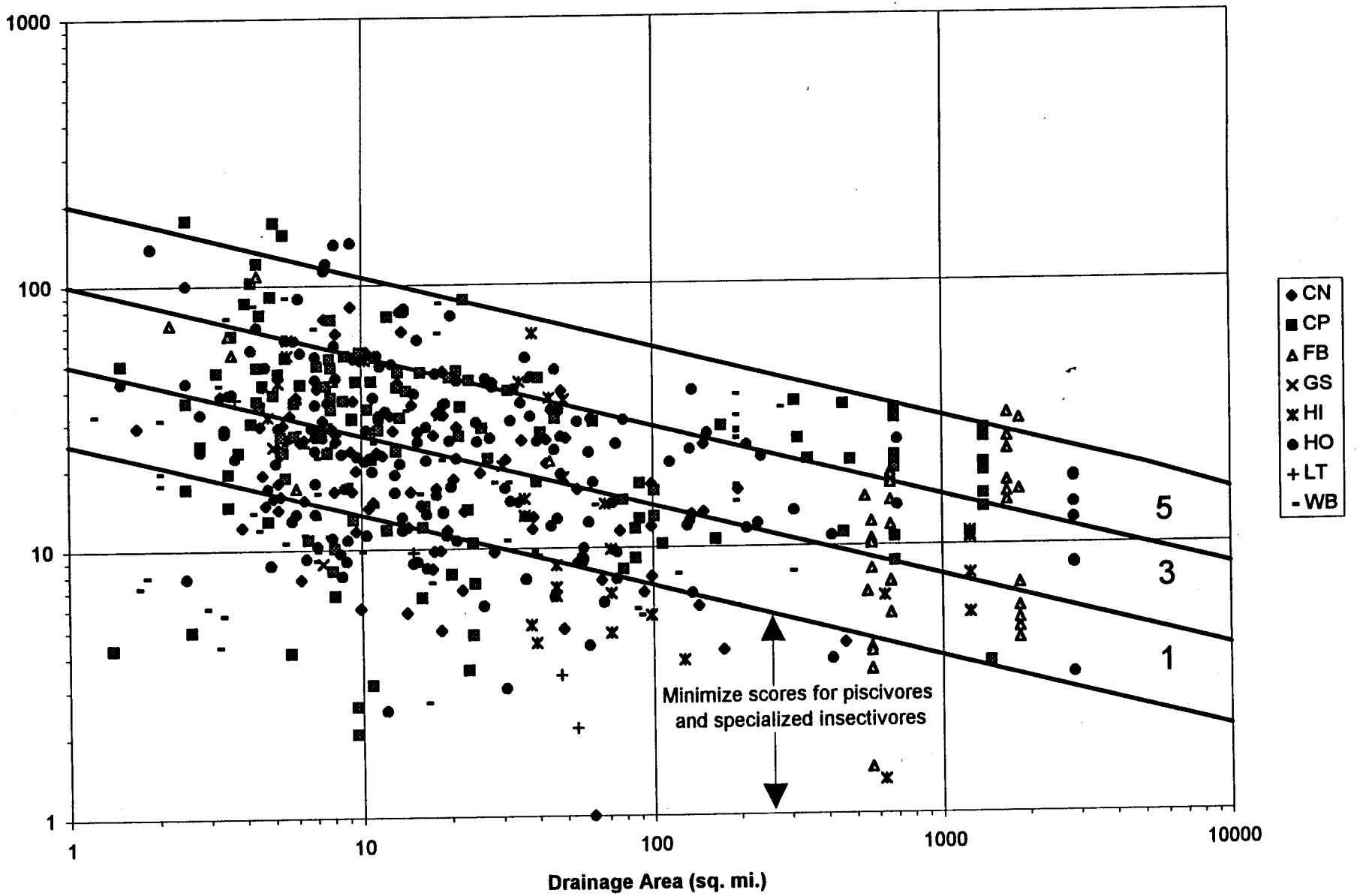
Ridge and Valley Ecoregion
% Specialized Insectivores



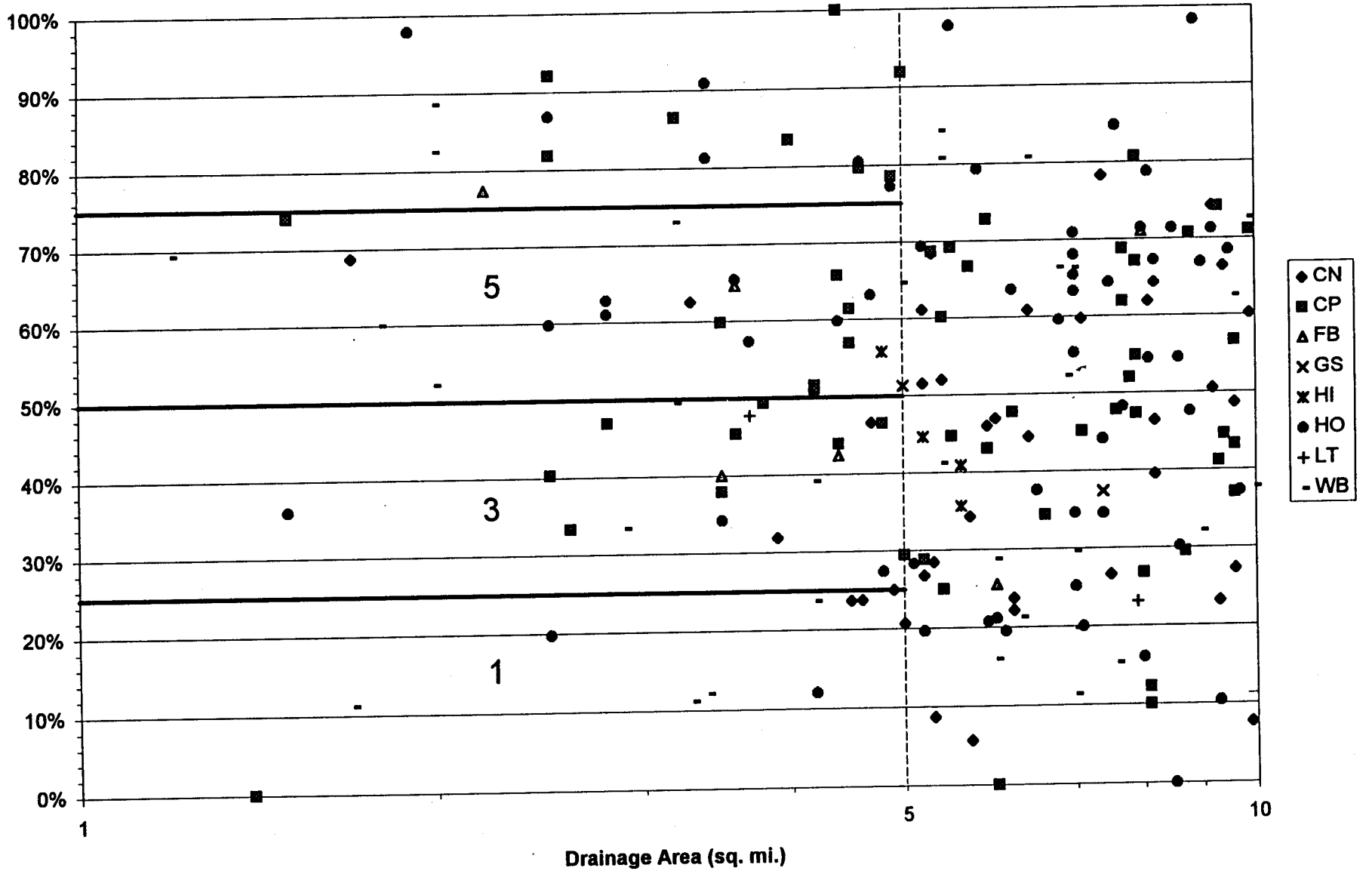
Ridge and Valley Ecoregion
% Piscivores



Ridge and Valley Ecoregion
CPUE



Ridge and Valley Ecoregion
% Lithophilic Spn.



Ridge and Valley Ecoregion
% Anomalies