GUIDELINES FOR STOCKING TROUT STREAMS
IN NEW YORK STATE

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PREFACE

Stocking of hatchery-reared trout is only one of several tools used to improve trout fishing in New York public waters. In general, if a stream section has good public access and acceptable trout habitat, but not enough natural reproduction to support a satisfactory fishery for wild fish, it is stocked. However, definition of a satisfactory fishery for wild trout is, of course, a subjective judgement. In some cases, it is desirable to leave a relatively unproductive wild trout stream unstocked because the majority of its anglers enjoy fishing for wild trout. Reasons for esteeming wild fish are numerous and include physical appearance and coloration, real or presumed culinary superiority, and association with beautiful surroundings.

Besides these reasons, wild trout in streams also provide the chance to catch a larger than average fish. Creel census data and population studies from many New York streams show that larger trout admired by anglers are usually wild trout, rather than hatchery holdovers (Engstrom-Heg, Hulbert, 1983). The value of a fishery, as public wealth, is a function of quantity times quality (Engstrom-Heg, 1981). The quality of the wild trout fishing experience is viewed by some anglers to be so desirable that they are willing to forego a high catch rate to preserve it.

However, trout stream studies have demonstrated that stream stocking, as practiced in New York, has not been found to be detrimental to wild trout stocks. Therefore, we manage the majority of New York's larger public trout streams to support a combination of wild and stocked trout, and have done so for decades. This allows the stream to support a much higher angler-use while maintaining satisfactory catch-rates. There is no mandate or objective for DEC to stock all waters that meet the criteria for stocking. But, where angler catch-rate is an objective for a fishery, stocking is one means of attaining it.

These guidelines provide a system for arriving at stocking policies that give logical consideration to: contribution of wild trout, stream carrying capacity and fishing pressure. It is an improved modification of previous systems used in New York. With the adoption of this manual, all stream survey data collected for the purpose of setting trout stocking policies will be collected according to the specifications in this manual. The guidelines, of course, are subject to modification, improvement, and updating.

Although other trout stream management issues are peripherally discussed, this manual is not intended to be a comprehensive guide to all trout management practices. It is focused only on those that are related to stocking in streams.

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I GENERAL PRINCIPLES.

Catch-Rate Oriented Trout Stocking (CROTS) is aimed at putting the trout where the anglers are, and at the same time putting them where those that are not caught can survive and grow to be caught later. This means stocking enough fish in a given stream section to provide a satisfactory catch rate for the number of anglers that fish the stream, but not so many that the stream cannot support those that are not immediately caught out. Doing this requires at least rough estimates of fishing intensity, of the catchability of the stocked and resident fish, of the biomass of the latter, and of the carrying capacity of the stream. The theoretical basis for doing this rests to a large extent on certain generalizations derived from the 1978-1980 evaluation of trout size limits (Engstrom-Heg and Hulbert, 1983). These include the following:

(1) Viable lots of hatchery yearling brown trout stocked at moderate densities in acceptable habitat with low densities of wild trout typically have a natural mortality rate of about .002 per day (52% per year).

(2) The corresponding mortality rate for wild brown trout is about .001 per day (31% per year).

(3) The specific catchability (proportion of the current population caught per hour of fishing per acre of water (Engstrom-Heg, 1986a)) of stocked brown trout is about .008. Values for wild brown trout are age-dependent, but much lower.

c

(4) Reasonable predictions of wild brown trout yield can be made from yearling population density and fishing intensity (Engstrom-Heg, 1986b). Rough estimates of the same type can be made for brook and rainbow trout.

if all fish removed $.992^{100} = .45$, $.992^{200} = .20$, $.992^{300} = .09$

if 12½ % of catch are creeled then c = .001

$.999^{100} = .905$
$.999^{200} = .82$
$.999^{300} = .74$
$.999^{400} = .67$

(5) Fishing intensity in most New York streams is highest in April, and tends to taper off in a regular fashion as the season progresses. It is not usually closely associated with the stocking schedule. The pattern is more extreme where summer fishability is poor because of brush, low water, etc.

(6) Fishing intensity in New York streams varies greatly in relation to access, nearness to population centers or summer tourist areas, the reputation of the stream, and perhaps other factors.

(7) Carrying capacities estimated from the product of the factors F x H x N (fertility, habitat, non-trout fish) (Engstrom-Heg, 1979) corresponded reasonably well with observed biomasses of trout in lightly-to-moderately fished wild trout streams.

The goal for high-quality (Grade A, see p. 31) stream sections is to provide, for each month of the season, an average catch rate of at least 0.5 fish per hour, and a level of trout abundance that can support an average take-home harvest of at least 0.1 pounds per hour.

For less productive streams (Grade B, see p. 31), the goal is the same except that the "season" is taken to be an 8-week period in the spring. It should not be necessary to point out that these are not streams that dry up or become too warm for trout survival in the summer. These streams should not be stocked. A trout stream may be classified as "grade B" if summer flows or temperatures are marginal, but still capable of sustaining trout on a yearround basis, if streamside vegetation makes the stream difficult to fish in the summer, or if the estimated carrying capacity is low because of low inherent fertility or a shortage of good physical habitat.

Stocking of no-kill or virtual no-kill areas (high length limit) is aimed at an average catch rate of at least 1.0 fish per hour during each month. Skillful anglers will usually be able to do better than this.

Stocking rates are derived from the iterative use of a computer program based on the FORTRAN model STREAM SOURCE 1 (Engstrom-Heg and Engstrom-Heg, 1984), with stocking adjusted to provide the desired catch rates. Fish stocked in April were assumed to be 8 inches at stocking, to grow to 10.6 inches by the following spring (an approximate doubling of weight), to have a natural mortality rate of .002/day in Grade A and .004/day in Grade B stream sections and specific catchabilities corresponding with the mean monthly values given in Table 2 of Engstrom-Heg and Hulbert (1983) for stocked brown trout in New York streams, corresponding with seasonal values of .00833 for yearling and .00529 for holdover fish. Stocking of put-grow-take (PGT) sections (Types As, As9, Bs, p. 4 & 5), was assumed to occur in mid-April and in late May or early June if required. Put-and-take streams (Type Bp) and heavily-fished streams with a put-and-take first increment (Type Asp) were assumed to be stocked in late March or early April, with a second put-and-take increment in late April or early May.

Stocking rates are adjusted for estimated catch of wild fish. For instance if the wild trout catch rate is 0.2 per hour, stocked fish would be expected to provide 0.3, not 0.5 fish per hour.

Carrying capacity estimates are used to provide an upper limit for stocking. In PGT sections the total biomass of newly-stocked, previous-increment, holdover, and wild fish at the time of stocking should not exceed 75% of the estimated carrying capacity. Because carrying-capacity estimates are relatively imprecise, use of 75% provides a good safety margin to insure that the stream is not overstocked. Put-and-take

(P & T) stockings should not elevate total trout biomass above 150% of the estimated carrying capacity. This is tolerable because it is assumed that this population will be quickly reduced by the fishery. If this is not the case, the section should not be considered put-and-take. In streams with fishing intensities of 450 hours/acre and over, with no size limit, early increments are always put-and-take (Type Asp).

To determine a stocking rate, it is necessary to have at least rough estimates of the following:

1. fishing intensity and pattern
2. area of stocked section
3. wild age 1+ trout population density
4. wild trout biomass density (or wild trout catch rate from census)
5. Carrying capacity, as estimated from F x H x N, and later adjusted for stream width.

The stream section must also be assigned a management type. The types have a biological and demographic basis, but are not rigid. There is room for alternative management regimes. It should be noted that they are intended for guidance in formulating stocking policies or fishing regulations. They are not meant to imply in any way any judgment regarding the quality or value of any stream or group of streams. The types are as follows:

Bw Infertile or habitat-deficient wild trout streams lacking significant unused carrying capacity. Not stocked.

Bs Infertile or habitat-deficient streams, often small, with significant unused carrying capacity and a light-to-moderate fishery. Stocking provides for an early-season fishery and some holdover.

Bp Put-and-take streams characterized by a moderate-to-heavy fishery, and relatively little potential for wild and holdover contribution.

Aw Productive wild trout streams with light to moderate fisheries. Not stocked. No size limit.

Aw9 Wild trout streams managed under a 9-inch limit.

Aw10 Special regulation areas based on wild populations, with a 10-inch, 3-fish, artificials-only regulation.

Awp Heavily-fished wild trout streams lacking significant unused carrying capacity, and inappropriate for a size limit. Wild population is supplemented by stocking of put-and-take fish to provide for the early-season fishery.

As Stocked streams with no length limit, having significant unused carrying capacity and a light to moderate fishery. Stocked with put-grow-take fish, usually in two increments.

As9 Stocked streams managed under a 9-inch length limit, typically the larger, more productive, more heavily-fished streams, characterized by superior growth and survival.

As10, As12, As14, AsNK. Special regulation areas based primarily on stocked trout.

Asp Heavily-fished stocked streams of good quality, with significant holdover, but not managed under a length limit. The early-season fishery is provided for by a combination of put-and-take fish and holdover fish from a late spring stocking during the previous spring.

It should be obvious that for some stream sections there will be a choice of management types, depending on the judgement of the manager as to what regime might work in a given fishery. The key to management types (Appendix I) is intended as an aid to placing a stream section in the proper category. It need not be followed mechanically. The examples in Appendix III should also be useful in conceptualizing the management types.

II. SPECIFIC PROCEDURES AND CONSIDERATIONS.

A. WORKSHEETS AND REPORTS: The "CROTS WORKSHEET" used in examples 1-7 is based on a form that has worked well for Region 4. Computer programs will be developed to summarize standing crop and carrying capacity estimates using data recorded on the new field forms, and with the additional input of estimated fishing intensity and management type, to print out a "report" similar to the CROTS worksheet. This promises to be a big time-saver. However, even with this, any seemingly unreasonable outputs should be checked against a hand-calculated version. A supply of CROTS worksheets will be distributed to all Regions. Stocking policy revisions will be forwarded to the Coldwater Unit Leader for review on these worksheets.

B. LENGTH, WIDTH AND AREA: Width is the mean of the mean widths of the survey stations included in the section, assuming that these were measured in late summer or fall, but not after a heavy rain or during a period of extreme drought. Width at "normal summer low flow" is an obvious approximation, and may vary from year to year. Where there are several year's data for a section, use the mean of what appear to be valid measurements. For estimation of area, width is rounded to the nearest foot. The length of the section is measured to the nearest 0.1 mile, using a map measure on a USGS topographic map, or river mile designations from the Fisheries Database. Area is calculated to the nearest acre as: Area (acres) = width (ft) x length (miles/8.25).

Posted and inaccessible area: Short reaches of posted water are included in the section area. Where posting continues for more than a mile, the areas open to public fishing above and below the posting should be estimated separately and the posted area deleted from the stocking recommendation. Large inaccessible areas (over 10 acres) should be handled in the same way. Surveys to determine extent of posting should be updated as needed, or at least every 5 years. To qualify for stocking in New York, waters must be open to public fishing and have reasonable public access.

C. FISHING INTENSITY AND PATTERN

Pattern refers to seasonal distribution of fishing effort, which in New York streams shows a relatively consistent pattern of heavy exploitation in April that tapers off as the season progresses. Where there are creel census data, a stream section is "pattern 1" if April fishing accounts for less than 40% of the total, and at least 20% of the fishing occurs after July 1. If the fishing effort is more heavily loaded toward the early part of the season, it is "pattern 2". Where full-season creel census data are lacking larger streams with stable flows, good thermal regimes, and banks without excessive summer brush will usually be "pattern 1". Other streams will be "pattern 2". Where there is doubt, assume "pattern 2".

FISHING INTENSITY is measured in hours per acre for a full fishing season. Where creel census data are lacking, this will be a rough approximation. Where there has been a partial (April 1 - June 30) creel census, multiply the total by 1.33 for "pattern 1" and 1.18 for "pattern 2".

Where a creel census indicates an intensity greater than 750 hours per acre, use 750 except in estimating the wild yield (WY) factor.

Where creel census data are lacking, fishing intensity may be estimated as follows:

"light" - 150 hours/acre

"moderate" or "average" - 300 hours/acre

"heavy" - 450 hours/acre

"very heavy" - 600 hours/acre

"extreme" - 750 hours/acre

If fishing intensity is completely unknown, assume 150 hours per acre for streams with reasonably good access, except as follows:

Regions 1 and 9 - 300 hours/acre

Adirondack and Tug Hill portions of Regions 5 and 6 - 150 hours per acre except near heavily-used public campgrounds or similar heavily-used areas.

Within 15 miles of Albany, Troy, Schenectady, Rome, Utica, Syracuse, Rochester and Binghamton - 300 hours/acre

Lower Hudson Valley and associated population belt - 300 hours/acre

If access is poor, estimated intensity may be dropped one step, or if the stream is closely followed by a good road with many access points, it may be raised one step. These criteria may not be appropriate for very large streams without continuous fishable trout habitat. Here a low number of hours per acre may actually represent an intensive fishery on a localized trout population. If this appears to be the situation, assume 150 hours/acre, or 300 hours/acre if there is evidence of a rapid fish-out of early increments (See IV A. "Large Streams").

D. PREDICTED YIELD FROM WILD TROUT (WY)

Catch rate of wild trout is predicted from fishing intensity and the estimated population density of yearling fish, as described by

Engstrom-Heg (1986b). The factor "WY" (for "wild yield") represents the predicted catch rate of wild trout. The appropriate equations are as follows:

For brown trout with no size limit (Type Bs, As, AsP) BW AW

$$WY = N_1/(0.9f + 420)$$

For brown trout under a size limit (Types As9, As10) AW9 AW10

$$WY = N_1/(0.6f + 375)$$

For brown trout in no-kill or virtual no-kill sections (Types AsNK, As14, As12)

$$WY = N_1/(.08f + 290)$$

For brook and rainbow trout

$$WY = N_1/(1.10f + 190)$$

Where WY = estimated yield of wild trout as number caught per hour

f = fishing intensity in hours per acre

N_1 = number of wild yearlings per acre

The first two equations are from Engstrom-Heg (1986b), the third is a theoretical extension from these. The equation for brook and rainbow trout is something of a compromise based on estimated catch rates of these fish in streams studied during the 9-inch study. Table 1 (p. 50) lists values of WY corresponding with most combinations of fishing intensity and yearling population density. For fishing intensities greater than 750 hours per acre, use the equations, and the actual value of "f", rather than 750.

Values for different species are added.

Let us say we have estimated wild yearling population densities as follows in a type As stream fished at 300 hours per acre:

BROWN TROUT - 50/acre

BROOK TROUT - 25/acre

WY(BT) = 50/(.9 (300) + 420) = .072

WY(ST) = 25/(1.1 (300 + 190)) = .048

TOTAL WY = .120

Since the estimate is very approximate, it is rounded to the nearest tenth of a fish per hour. For estimation of stocking rate, WY = 0.1.

If there has been a creel census where catches of wild and stocked trout were clearly separated, the estimated wild trout catch per hour takes precedence over an estimate based on yearlings.

Wild yearlings usually appear in stream survey length frequency distributions as a mode somewhere in the 5-8 inch range. If there are scale readings, a mode of yearling fish in the 8.5-10 inch range will usually be hatchery fish. Otherwise assume wild origin unless the fish have been identified as stocked trout by fin-clips, scale readings or general appearance. Accept the latter with some caution. It usually works with yearlings if both wild and stocked fish are present.

The population density of wild yearlings may be estimated as:

N_1 = number collected/station area/electrofishing efficiency, or from a mark-and-recapture or removal population estimate. For deriving estimates from old data, see p. 14-19.

Where there is more than one survey station in a stocked section, use the total estimated number of yearling fish, and divide by the total area.

Where there has been a series of acceptable surveys in successive or alternating years, average the yearling population densities.

If WY is less than 0.05, the wild trout contribution can be regarded as negligible, so WY = 0. If WY is greater than 0.35, the stream will usually not be stocked.

E. WILD TROUT BIOMASS

This is estimated as pounds per acre, from electrofishing data. For new surveys, the necessary raw data will be recorded on RECTYPE E, Individual Fish Survey Data and RECTYPE GE, Gear, Electrofishing Record. It is anticipated that a computer-generated report will be developed to estimate wild trout biomass from the data entered on these forms. In the meantime it will have to be calculated manually. For this purpose, group the fish identified as wild by centimeter or half-inch length classes, multiply by the weight (in pounds) corresponding with the mid-point of the length class, (Table 2, p. 52) and add to find the total collected biomass. To obtain pounds per acre, divide by the area of the station(s) and the electrofishing efficiency, as was done for wild yearling population density.

Where there is more than one survey station in a stocked section, use the total estimated wild biomass and divide by the total area.

Where there has been a series of acceptable surveys in successive or alternate years, average the biomass estimates.

A detailed example of estimation of biomass density from old data is given on p. 17-19.

F. ESTIMATING THE CARRYING CAPACITY AVAILABLE FOR STOCKED TROUT

Carrying capacity (CC) for trout, in pounds per acre, is estimated from the product of the factors F (fertility), H (habitat) and N (non-trout fish) using the equation.

$$CC = 73.3((NHF)^{1/3} - 0.80)$$

Methods for estimating F, H and N are described in detail in Appendix II, p. 35-46.

It should be noted that there is nothing "sacred" about this system. It is used because, at least so far, estimated carrying capacities have tended to correspond rather well with wild trout biomasses in self-sustaining streams. If a superior system comes along, it can be adopted and/or adapted, and substituted for F x H x N as a basis for estimating carrying capacity. The Habitat Quality Index (HQI) described by Binns (1979) is an interesting effort in this direction that might be useful for large streams where measurement of the H factor is difficult.

It is anticipated that a computer-generated report will be able to estimate values of F and H from the data fields in RECTYPE SC (Stream Characteristics Record) and N from non-trout data recorded on RECTYPE F (Bulk Catch Desciptive Data), and compute the estimated carrying capacity. Until this is available, follow the procedures in Appendix II. For old survey data, see p. 19.

Table 3, p. 54 can be used to find the carrying capacity corresponding with a given value of F x H x N. Estimates for intermediate values can be obtained by linear interpolation.

The values representing 0.75 and 1.50 times the estimated carrying capacity (columns 3 and 4) are used in setting stocking rates.

The width adjustment is a somewhat arbitrary adaptation of an adjustment used by Leger (1910). There is little doubt that large streams have less carrying capacity per unit area than smaller ones of similar quality, but the exact form of the variation is uncertain. A plot of the values in Table 4, p. 56, forms a smooth curve that is roughly similar to the stairstep function used by Binns (1979) in the HQI, where width is one of the determinants of carrying capacity.

It should be noted that the resulting estimates of carrying capacity are default values, to be used in the absence of better information. If there is clear evidence that the stream section in question has sustained a larger biomass, averaged over a representative reach, on a continuing basis with good growth and survival, the estimate may be increased. If emaciation or poor growth have been observed at biomass densities at or lower than the estimate, the estimate should be reduced.

G. THE STOCKED BIOMASS LIMIT (SBL)

The adjusted value of 0.75 CC is a conservative estimate of the carrying capacity available for all trout. The wild trout biomass is subtracted from this to obtain the SBL, the carrying capacity that is available for stocked trout.

H. THE STOCKING TABLES

Tables 5 through 13 list recommended stocking rates for the various management types at a series of fishing intensities. These are based on computer runs that resulted in the desired catch rate. Intermediate values can be obtained by linear interpolation.

Use the following tables for the following management types:

TYPE	TABLE
Bs	5
Bp	6
Awp	7
As	8
Asp	9
As9, As10	10 and 11
As12	12
AsNK, As14	13

In connection with each recommended stocking rate and schedule, the tables list a "Maximum Stocked Biomass" (MSB). It is important to note that this is not just the biomass of the fish that are to be stocked in a given increment, but also includes estimates, based on computer runs, of the biomass of HOLDOVER FISH AND SURVIVORS FROM EARLIER INCREMENTS, in other words, the total biomass of STOCKED fish (pounds per acre) that will be present in the stream after the fish are stocked and have dispersed.

I. ADJUSTMENT FOR AVAILABLE CARRYING CAPACITY

If the maximum stocked biomass (MSB) is less than the stocked biomass limit (SBL), use the stocking rates at their full value. If it is greater than SBL, adjust the rates by a factor equal to SBL/MSB.

For the Asp stream sections, the stocked biomass limit is determined from 1.50 CC for the March - April and May P & T increments and 0.75 CC for the May - June PGT stocking. In all other cases, the biomass correction is applied equally to all increments.

J. FINAL DETERMINATION OF STOCKING RATE

Stocking rates are given in Tables 5-13. Use the base rates for WY=0. Some of the tables list separate rates for other values of WY. On others, because of space constraints, it is necessary to multiply the base rate by an appropriate factor, given in the table. Rates are multiplied by the biomass correction, if any, then by the section area to obtain the number of fish to be stocked in the section. This will normally be rounded to the nearest 100 fish for stockings of 1000 or more, and to the nearest 50 fish for smaller stockings. See the Examples in Appendix III.

III. GUIDELINES FOR USING PAST SURVEY DATA

Estimates of yearling wild trout density, wild trout biomass and carrying capacity are based on survey data. It is anticipated that a software package will be available in the fairly near future that will calculate these automatically from the new survey forms. For some time, however, it will be necessary in the majority of cases to estimate these values from data recorded on the old forms. While much of old survey data is less than ideal, this prospect need not be frightening. It should be noted that for most moderately fished streams with sparse wild trout populations, the CROTS stocking rates can be used directly without adjustment for wild trout biomass or carrying capacity. The only reason for examining old records here would be to confirm that this is indeed the situation. For this purpose high precision is unnecessary, and indeed there may be no need to schedule a re-survey of such a stream section if the only reason for doing so is to set a stocking policy. In most Regions a slight majority of stocked streams will fit in this category.

Where there is mediocre habitat, heavy fishing pressure or a substantial wild trout population, it is more likely that stocking rates will have to be adjusted for the amount of unused carrying capacity. Here survey data will often play a role, and if the most recent data are clearly inadequate or outdated, a re-survey is in order.

In using past data the following guidelines will be useful:

A. Choice of Survey Data: Use the most recent fairly complete survey of the section done under acceptable stream conditions in late summer or fall. Where there has been a series of acceptable surveys in successive or alternating years, average the widths, 1+ wild trout population densities and wild trout biomass densities, but use the most recent values for F, H and N.

B. Multiple stations: Where there is more than one survey station in the section, use total area surveyed, and total fish collections, but use average values for F, H, and N.

C. Electrofishing Data:

(1) Population estimates: If there has been a Petersen, or Leslie (DeLury) population estimate, the data can be used directy as a source of yearling population density and biomass density. If yearling fish and/or wild fish were not differentiated, make an approximate breakdown as described for single-sweep surveys. Handle weights and biomasses as for single-sweep surveys. Electrofishing efficiencies should be recorded for future reference. For a mark and recapture estimate, the first-run efficiency (E_1) is equal to the number of recaptured fish divided by the number of fish in the second-run sample ($E_2 = R/C$). The second-run efficiency (E_2) is equal to the number of recaptured fish divided by the number the were marked ($E_2 = R/M$). For a removal-type estimate, record the percent of the estimated population collected on the first sweep.

(2) Single-sweep surveys:

(a) Electrofishing efficiency: The listed efficiency may be a good or bad guess. Be skeptical of any very low reported efficiencies for yearling or older trout unless there is an obvious reason for them. Under normal conditions a good DC electrofishing team can usually get about 50% on trout over 5 inches in streams up to about 33 feet wide. If no efficiency or an unlikely efficiency is given, use the efficiency estimates listed in Table 14, p. 76.

(3) Weight of fish: Stream trout up to about 12 inches usually adhere closely to a simple length-weight relationship where $W = L^3/10^5$, with length in millimeters and weight in grams. For length in inches and weight in pounds, this is $(25.4\ L)^3/45454545$. Weight can also be estimated graphically from length, using the condition factor form (Figure 1). Estimation of weight from length is quicker and usually more accurate

than averaging the field-taken weight for a length class. If there is reason to think the fish may have been leaner or plumper than usual, plot some of the lengths and weights on the condition factor form (Figure 1). If the condition factor is noticeably above or below the 1.0 curve, adjust the total weight accordingly. For fish over 12 inches, use actual field weights if they have been recorded. Weights taken to the nearest ounce are not trustworthy for small fish. Weights taken to the nearest gram, 5 grams or hundredth of a pound are useful, but mainly for ascertaining the condition of the fish.

D. Data sorting: The form in which the electrofishing data are recorded will depend on the Region, the date, and the purpose of the survey. Sometimes there will be a list of fish lengths to the nearest millimeter or 0.1 inch, with or without age readings, weights, and notations as to probable origin, sometimes the data will be arranged in tabular form by age or length classes, and sometimes there will just be a listing of species with a range of lengths and perhaps a mean length and/or weight. This is the hardest form to deal with.

If there is a table with an adequate breakdown, it can usually be used directly to estimate 1+ population and wild trout biomass. If there is just a list, the data should be put in tabular form.

The following list is fairly typical.

STATION 1, 0.25A

Salmo trutta 4.3, 3.7, 4.1, 8.6, 6.1, 9.2H, 6.0, 11.3LV,
7.1, 9.3, 6.7, 9.0

STATION 2, 0.31A

Salmo trutta 4.0, 4.0, 4.1, 6.9, 8.6H, 15.0

STATION 3, 0.15A

Salmo trutta 4.1, 3.6, 9.2, 11.1, 12.2, 6.4, 6.7

Salmo gairdneri 2.4, 2.7, 2.8, 6.0, 12.0

Total area is 0.71 acres. Efficiency is estimated to be 0.33 for fingerlings and 0.50 for older trout. The two yearlings and one holdover identified as hatchery fish are assumed to be that. If there are no age readings, a useful preliminary step is to tally a length-frequency distribution with half-inch or centimeter classes for the wild fish. This will usually sort out the age classes fairly well. A finer or coarser breakdown does not work as well. For these data, it would look like the following:

	BT		RT	
6.0 - 6.4	111		1	1+
6.5 - 6.9	111	1+		
7.0 - 7.4	1			
7.5 - 7.9				
8.0 - 8.4				
8.5 - 8.9	1	2+		
9.0 - 9.4	111			
	BT		RT	
9.5 - 9.9				
10.0 - 10.4				
10.5 - 10.9				
11.0 - 11.4	1			
11.5 - 11.9		3+		
12.0 - 12.4	1		1	3+?
15.0 - 15.4	1	4+?		

The mode at 6.0 to 7.4 inches is assumed to consist of wild yearlings. Wild yearling population density is estimated to be 7/.50/.71 = 19.7 brown trout per acre, and 1/.50/.71 = 2.8 rainbow trout per acre. Wild yearlings usually appear as a mode somewhere in the 5-8 inch range. If there are scale readings, a mode of yearling fish in the 8.5-10 inch range will usually be hatchery fish. Otherwise assume wild origin unless the fish have been identified as stocked trout by fin-clips, scale readings or general appearance. Accept the latter with some caution. It usually works with yearlings if both wild and stocked fish are present.

To estimate wild biomass, group the fish by length or age classes. For our example, using inch classes, we could proceed as follows:

FINGERLINGS	L	W*	No.	No. x W
BT	4.0	.023	8	.18
RT	2.6	.006	3	.02
				.20/.33/.71 = .85
OLDER FISH				
6.0 - 6.9	6.4	.094	7	.66
7.0 - 7.9	7.1	.129	1	.13
8.0 - 8.9	8.6	.229	1	.23
9.0 - 9.9	9.2	.280	3	.84
10.0 - 10.9				
11.0 - 11.9	11.1	.548	1	.55
12.0 - 12.9	12.1	.638	2	1.28
15.0 - 15.9	15.0	1.217	1	1.22
				4.91/.5/.71 = 13.83
				14.7lb/A

*for mean length, as $W = (25.4\ L)^3/45454545$, calculated, or read from the K=1.0 curve on the condition factor chart.

If there are only a few fish in a class, use mean length. If there are a lot, use the mid-point of the length class.

An analysis by species and age class, using the same approach, yields practically identical results.

You may also encounter a notation of the following type:

SPECIES	NUMBER	LENGTH	WEIGHT (MEAN)
BT Adult	36	9.2(6.0-14.3)	.27 lb.

This is impossible to interpret with any precision. If this is all you have, a resurvey is strongly recommended.

E. F, H AND N DETERMINATIONS (See Appendix II). These are likely to be quite subjective under the old (pre - 1979) WNHF criteria. These should be checked against common sense and against what is known of the stream and its watershed. For instance, a value of N = 1 is unlikely for a headwater trout stream, as is N = 3 for a section bordering on warmwater habitat. With respect to the F factor, be aware of the underlying geology of the watershed. On igneous rocks, or on the calcium-poor Slide Mountain and Honesdale Formations (Southern Catskills), F will usually be fairly close to 1. It is likely to be around 2 on shales or sandstones, and close to 3 downstream from limestone or marble outcroppings (most of Region 8). If the recorded values are absurd in the light of present knowledge, do not hesitate to use more reasonable ones.

IV. PROBLEM AREAS

A. LARGE STREAMS: Many large streams do not lend themselves to habitat measurements or electrofishing surveys as usually conducted. The Binns (1979) HQI has already been mentioned as a possible substitute for the F, H and N indices. For some streams, nitrate nitrogen concentration, one of the factors used, can be found in the USGS annual bulletins, entitled Water Resources Data for New York.

Given the present state of the electrofishing art, creel census data will usually be more meaningful than electrofishing data for determining the situation in large streams. Where a full census is not possible, a mini-census, covering a month, or selected weekends, will often give a good idea of wild trout catch rate, which will usually remain fairly constant through the season. For determining WY, census data supercedes estimates based on yearling population density.

Electrofishing data from large streams is likely to underestimate the true wild trout biomass, since wadeable stations are not likely to represent the best trout habitat.

If there are good census data and the electrofishing data are lacking or apparently unrepresentative, the biomass density that would probably be needed to sustain a given catch rate can be roughly estimated as:

$B = 250Y$ for brown trout (based on Batten Kill data)

and $B = 150Y$ for rainbow trout (based on Catskill Creek data, but with better growth), where B is in pounds/acre and Y is catch rate in fish per hour.

Brook trout are not likely to be a major component of the catch in large streams. For instance if the catch rates from a census were:

Wild brown trout: .06/hour

Wild rainbow trout: .02/hour, wild trout biomass density could be estimated as

$$.06 \times 250 = 15$$
$$.02 \times 150 = \underline{3}$$
$$18 \text{ lb/acre}$$

For streams that have been surveyed by boat electrofishing, sections where trout have been rated at least "sub-dominant" (See Sheppard, 1983 for terminology) through most of the survey section, should be rated at least WY = .2 in the absence of other information. If trout are "dominant" or "co-dominant" and abundant in most reaches, the section will usually be classified as Aw, Aw9 or AwP. In the latter case, the wild trout population should be assumed to be at carrying capacity, which would make the stocked biomass limit for put-and-take fish equal to 0.5 times carrying capacity. As previously mentioned, census data from large streams may underestimate the true fishing intensity in those parts of the stream that are used by trout and anglers. Where this is suspected, an upward adjustment (see p. 8) is reasonable, and should be based on knowledge of the stream and its fishery.

B. FINGERLING STOCKING: The 1979 Stocking Criteria provided for fingerling or split policies, with fingerling numbers set at 1.73 times the yearling rates. This appears to have worked well in a few small, fertile streams, particularly in Region 8, though there have been no detailed reports on these streams. As9 (FY) policies appear to be working in Oriskany Creek (Region 6), and were perhaps marginally successful in Willowemoc Creek (Region 3) where they have been discontinued. Fingerling policies can still be used where there is evidence that they are working or might work. Their success requires good growth and survival rates. Bs(F) policies are unlikely to work, and should be changed to Bs or Bw.

For As(F) or As(FY) policies on small streams, fingerlings may replace any part or all of the spring stocking, at 1.73 fingerlings per recommended yearling. For As9(FY) stockings in large, fertile streams, all or part of the mid-April stocking may be replaced by fingerlings at the same ratio. Poststocking biomass from these stockings will usually run a little lower than with yearling stockings, but to insure good growth, the same biomass equivalents should be used.

C. THE STOCKING SCHEDULE: CROTS is based not only on numbers stocked but on time of stocking. At the time it was developed it seemed reasonable in terms of both biology and hatchery logistics to schedule most PGT stocking for mid-April with second increments where needed in late May-early June, and most P & T stocking in late March-early April, with second increments where needed in late April-early May. This still seems reasonable, though it is obvious that there can be exceptions to this pattern. Exceptions, however, should be for a well-thought-out reason.

Where different numbers of fish are assigned to early and late increments, this is done for a reason. In PGT situations, the mid-April increment is meant to satisfy the more intensive early fishery (as last year's holdovers are being caught out) and provide some fish for the summer fishery and a few holdovers for the next year. The late increment is intended to provide for the summer fishery and the majority of the holdovers. Where P & T fish are used they should be out there for the early anglers to catch. A second increment, if needed, should go in as the early increment is caught out, and should be proportional in number to expected fishing pressure during the second month of fishing, with allowance for some survival of early-increment fish.

For reasons that perhaps have more to do with inertia than anything else, some streams are now stocked with CROTS numbers of trout, but still in two equal increments, often one in early or mid-April and one in early or mid-May. This is not CROTS stocking, though in some cases it may approximate it. If the recommeded numbers for the two increments are approximately equal, there is no real harm in making them exactly equal for the sake of convenience.

The concept of stocking PGT fish in two increments is based on the assumption that the stream section to be stocked is reasonably large. It clearly makes no sense to make a special trip to a small stream with a hundred or so second-increment fish. If the recommendation calls for a very small second increment, and if the fish can not be stocked on the way to some larger stocking, it is better to go with a mid-April stocking only.

April-only stocking requires a slightly larger total number of fish than two-increment stocking to accomplish the same ends, and since these fish are stocked at one time, there are more likely to be carrying-capacity limitations, and greater likelihood of stocking all the fish intended for a section under unfavorable temperature or stream conditions.

It is of course impossible to combine type AsP management with one-increment stocking. A short, heavily-fished section that could only be stocked once should be classified as type Bp, or if there are enough wild fish to sustain the summer fishery, as type AwP. The stocking tables will accomodate most instances of one-increment stocking. If it should prove necessary to convert a two-increment stocking rate to April-only, multiply the total number stocked by 1.3 and the MSB by 1.5.

D. THE SPECIES MIX: PGT stockings in streams should be brown trout. This species has the best record, uneven though it is, of natural survival and growth in New York streams. There appear to be no documented cases of really good long-term survival of stocked domestic brook or rainbow trout in New York streams. Rainbow trout, because of their size and aggressiveness, and brook trout, because of their beauty, and because of their possibly greater tolerance for acidic water, may be good choices for P & T increments. Brown trout are the best choice for type AwP situations. There is evidence (Vincent, 1987) that stocking of large rainbow trout at high densities has a negative impact on wild trout populations. Data from Esopus and Catskill Creeks (Engstrom-Heg and Hulbert, 1983) indicate no such effect from continued heavy stocking of yearling brown trout over wild rainbow trout populations. If any generalization can be drawn from situations where brown trout were stocked over substantial wild brown trout populations, it is that survival of the stocked fish tended to be poorer than average.

E. SIZE OF STOCKED FISH: CROTS is based on an assumption of 8-inch brown trout yearlings, which were the usual hatchery product at the time it was developed, and which still probably predominate on a statewide basis. Larger yearlings, however, have become more common in recent years. If production of larger fish were to become predictable and nearly universal, the CROTS tables and graphs would have to be revised in terms of both stocking regimes and biomass estimates. For instance if mean length at stocking is 9 inches, a 9-inch limit will provide less protection and first-increment fish will be fished out more rapidly than if the mean length were 8 inches. If it appears likely that the fish available for stocking in a type As9 section are regularly going to have a mean length OVER 9 inches, then the section should be stocked as if it were type As. Biomass of stocked fish will also be higher if the fish are large. The values for maximum stocked biomass in the tables should be multiplied by an appropriate factor if large fish are expected to be the rule. These factors are as follows:

EXPECTED MEAN LENGTH	FACTOR
9.0"	1.4
9.5"	1.7
10.0"	2.0

Small yearlings present a different problem. There is no evidence that their survival in streams is any poorer than that of larger fish, but if there is a size limit they will usually not be recruited early enough to be of much value to the first-year fishery. Where possible, avoid stocking lots with mean lengths less than 8.0 inches in type As9 streams. Streams known to have exceptionally good growth rates might be an exception, but angler acceptance is likely to be poor.

F. EXCEPTIONS TO CROTS: CROTS was developed in part to get away from the WNHF requirement that streams be stocked in proportion to their carrying capacity regardless of the likely harvest pattern (streams could be removed from the stocking list if they showed a poor return rate, but this was not a common practice). It is true in general that if a stream has enough wild fish to provide a satisfactory catch rate at current fishing intensities, it is better to put stocked fish elsewhere, even though the stream may be able to accomodate some. It is not good management to create an unusually high catch rate in one stream section and at the same time short-change another where the demand may be greater. Exceptions, however, are possible. For instance, the lower West Branch Delaware River is a fertile tailwater that under normal flow conditions supports a fine fishery for fast-growing wild brown trout of tributary origin. The appropriate management type in terms of the standards presented in this Guide would probably be Aw10. However, it has been found that stocked fingerling and yearling brown trout show unusually good growth and survival in this section. Because of high fertility, ideal temperatures and relatively low recruitment of wild fish, there appears to be substantial unused carrying capacity. It is possible that the addition of stocked fish could convert an already good large-river trout fishery to a truly outstanding one. A narrow interpretation of CROTS should not be allowed to stand in the way of a unique opportunity of this type. This section also appears to be an exception to the generalization that length limits over 10 inches are unlikely to be successful for wild trout in New York streams.

G. WHEN NOT TO STOCK: Stream sections that meet the criteria for Types Aw or Bw, or that lack year-round trout habitat (including the HF = 0 category, Appendix II, p. 41-42) are not stocked. Certain other classes of stream sections should generally not be stocked, even though they might technically meet the qualifications for stocking. These include:

(1) Very small streams (width less than about 10 feet) or very short sections (open accessible area less than a mile), or sections that would receive a total stocking of less than 300 fish.

(2) Streams where there is likely to be very light fishing pressure (less than about 75 hours per acre on small or medium sized streams).

(3) Streams with evidence of consistent poor survival of stocked fish, as shown by a return of less than 45% of stocked fish in an April 1-July 1 creel census, in the absence of a length limit, or a return of less than 15% in a tagging study.

(4) Streams that already support adequate fisheries for smallmouth bass or walleye, even though some of these might technically qualify as "trout streams".

A finding that a stream section might be stocked under one of the CROTS management types does not necessarily mean that this is the best management choice for the section. For instance in the case of a small, relatively infertile stream with some wild fish, it might be better to classify it as Type Bw, rather than call it say "Bs, WY = 0.3" and bring in a small number of stocked fish from a considerable distance. Choices of this type require a consideration of geographical factors, including the availability of trout fishing opportunity, angler attitudes and hatchery logistics, as well as the biology of the stream.

H. DISTRIBUTION OF STOCKED FISH: Stocking points should be spaced at relatively even intervals throughout the open (non-posted) portion of stocked section. Intervals should include about 10 acres of stream on medium-sized streams (about two miles at a 40-foot width). Area between stocking points should generally be less than this on very small streams, and may be more on large, wide streams. Wherever feasible, fish should be scatter-planted through a distance of 0.5 miles upstream and downstream from a stocking point to facilitate dispersal.

I. SURVEYS AND IMPLEMENTATION: CROTS is considerably less dependent on survey data than the former WNHF system. Many streams can be stocked at the full CROTS rate without any danger of overloading the habitat. This will almost always be the case where fishing pressure is relatively light and the wild trout population is sparse. It would not be difficult to pick out many of these streams and immediately put them under CROTS policies. No great harm would be done if all of the smaller stocked sections in the more sparsely populated parts of the state were stocked at the full rate for an assumed fishery of 150 hours/acre, with a correction for wild trout contribution if this was thought to be significant. Resurvey efforts might eventually uncover some errors in this, but the net result would be close to CROTS standards, and would be a more rational stocking policy than could be achieved by clinging to stocking rates based on old WNHF or even pre-WNHF surveys, or mere tradition. A survey effort is needed, but it should be concentrated on the more heavily-fished streams and those where there is reason to think the survey results might change the stocking rates.

J. CLASSIFICATION OF WILD TROUT STREAMS: Wild trout streams are those that support all the wild trout they can, or enough of these fish to sustain a satisfactory fishery at current fishing intensity. They are classified as Bw, Aw, Aw9 or Aw10 depending on their quality and management type, regardless of whether or not there is significant spawning or nursery habitat within the section. This is better than the ambiguous term "NSA".

These classifications are not really a part of CROTS, since they do not involve stocking. At first glance they may seem somewhat pointless. However, it is useful to have a somewhat more detailed inventory of wild trout waters than just "miles of NSA". If a stream section is threatened by habitat changes, it is important to be able to point out the value of the stream in terms of its classification and the magnitude of the fishery it could safely sustain.

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