MONTANA STATE DEPARTMENT OF FISH AND GAME
FEDERAL AID IN FISH RESTORATION SECTION
HELENA, MONTANA

JOB COMPLETION REPORT
INVESTIGATIONS PROJECTS

State of Montana

Project No. F-8-R-4 Job No. I

Title of Job: Development of a manual on trout culture for the Montana Fish and Game Department

Abstract:

A subject-indexed bibliography of approximately 2,000 references on trout culture was typed on 3 x 5 cards and filed alphabetically by author. A library of approximately 1,300 of these publications was collected and most of the remaining 700 publications were available to project personnel through the Greater University System of Montana libraries. This literature along with first-hand observations on trout disease and nutritional problems in Montana hatcheries was used to prepare the "Trout Hatchery Manual" which contains sections on fin rot, furunculosis, gill disease, blue-sac disease, vitamin A, Saprolegnia parasitica, ichthyophthiriasis, octomitiasis, gyrodactyliasis, gas bubble disease, and appendices on composition and vitamin content of hatchery foods, and useful conversion tables. Technical terms were avoided or defined in the text as an aid to assimilation of the information by hatcherymen. Extensive lists of literature were included with each section of the manual as an aid to further study by students and other interested workers.

Objectives:

To summarize and assemble material from the available literature into a manual on trout culture with emphasis on disease and nutrition.

Techniques Used:

A bibliography and library on trout culture was assembled and kept up to date with additions from current literature. Publications that were available in the library collected for the Fish and Game Department, the personal libraries of the project personnel, and in the libraries of the University of Montana at Missoula and the State College at Bozeman were cross-indexed by subject. The subject index was arranged alphabetically by subject on typewritten 3 x 5 cards and the bibliography was filed alphabetically by author also on typewritten 3 x 5 cards.

Literature reviews were written for those disease and nutritional problems encountered and identified at Montana hatcheries. These reviews along with

firsthand observations were assembled to make up the present "Trout Hatchery Manual". A complete list of the literature references on each subject was included as part of the manual to facilitate future research. Considerable effort was made however, to keep the text of the manual in a form that would be read and assimilated by fish-culturists. Technical terms not commonly used by fish-culturists were either avoided or defined when necessary to maintain biological correctness of thought.

It is intended that frequent revisions of the manual be prepared as dictated by new findings reported in current periodical literature on trout culture. Therefore, a system of numbering subject material rather than pages was adopted. This numbering system permits removal of out-of-date sections and insertions of new or revised sections without the need of reproducing the entire manual.

Findings:

A total of 2,018 references were assembled into a bibliography on trout culture. Approximately 1,300 of these publications are in the custody of the project personnel either as personal property or as property of the Montana Fish and Game Department. Most of the remainder are readily available on library loan from the University System of Montana.

The subject index included approximately 300 subjects as listed below.

Subject	Number of References
Acanthocephala	7
Achlya	1
Acidity and alkalinity	29
Acriflavine	3
Actinomyces	6
Adrenal	1
Aerators	14
Age and Growth	24
Algae	12
Alkalinity (See Acidity and alkalinity)	
Amino acids	6
Anasthetics	19
Anatomy	14
Anemia	22
Anomalies	7
Anorexia	1
Antibiotics	23
Aphanomyces	1
Aquarium	6
Arachnida	1
Artificial propagation (see fish planting experiments)	
Ascorbic acid	1
Astacin (see Carotenoids)	
Astaxanthin (see Carotenoids)	
Bacillus columnaris (See columnaris)	
Bacteria	68
Bacteria -- spoilage	14
Bacteria -- technique (see Methods -- bacteriological tech.)	
Bactericides	30

Subject	Number of References
Bacterium salmonicida (see Furunculosis)	
Bibliographies	22
Biology	4
Biotin	15
Blood	91
Blue-sac (also see Dropsy)	13
Blue-sline (see Biotin)	
Bottom fauna	2
Brain	1
Breeding habits	2
Calcium-phosphorous	12
Carbohydrate	16
Carbon dioxide (see also respiration)	24
Carcinoma	2
Carrying capacity (see Production capacity)	
Carrying capacity -- lakes	1
Carrying capacity -- streams	
Cestodes	24
Chemistry (also see Methods -- chemical analyses)	32
Chlorine	12
Cholesterol	3
Choline	1
Cod-liver oil	30
Cold temperature disease	2
Collection and preservation	1
Color (see Pigmentation)	
Columnaris	20
Commercial fisheries	1
Condition factor (see Weight-length relationships)	
Conversion	
Copepoda (see Crustacea)	
Copper sulphate	4
Costia	13
Cover	2
Creel census	33
Crustacea	31
Culture media	35
Current	5
Cytophaga (see Myxobacteria)	
DDT	18
Deformities (see Anomalies)	
Dermocystidium	1
Diets	85
Digestion	11
Disease control	141
Dropsy (also see Blue-sac)	5
Ecology	15
Eggs	97
Electricity	16

Subject	Number of References
Elevation	1
Embryology	12
Enteritis	1
Enzymes	5
Explosives	1
Exophthalmia (see Pop-eye)	
Eye (also see Pop-eye)	10
Factor H (see Nutrition)	
Farm Ponds	20
Fasting	4
Fat	8
Fatty degeneration	
Fatty infiltration	11
Feeding -- techniques	32
Fertilizers	15
Fillers	7
Fin rot	23
Fins	7
Fin-clipping (see Marking)	
Fish barriers	2
Fish food, analyses	75
Fish food, potential sources	138
Fish planting experiments -- catchables in lakes)	
Fish planting experiments -- subcatchables in lakes)	
Fish planting experiments -- catchables in streams)	120
Fish planting experiments -- subcatchables in streams)	
Fish pox	1
Fish, reduction processes	14
Folic acid	9
Food -- freezing, storage, and preservation (also see Fish, reduction processes)	42
Food studies (natural food of wild fish)	18
Forage fish propagation	3
Freezing (see Food -- freezing, storage, and preservation)	
Fungus (see *Saprolegnia* spp., *Ichthyosporidium*, *Heterosporidium*, *Aphanomyces*, and *Achyla*)	
Furunculosis	67
Gall bladder	2
Gas bubble disease	11
Germicides (see Bactericides)	
Gill	41
Gill Disease	37
Glochidia (see Mollusca)	
Glucose (see Carbohydrates)	
Glycogen	11
Grayling	2
Growth	82
Gyrodactyliasis	24
Hearing	2
Heart	1
Hemophilus	1

Subject	Number of References
Hemorrhage	1
Heredity	31
Heterosporidium	1
Histology	7
Homing	1
Hormones	19
Horse meat	2
Hybrid	2
Hydrocoele embryonalis (see Blue-sac)	
Hydroxylamine	2
Hypnotics (see Anasthetics)	2
Ice (see Snow and ice)	
Ichthyophthirius	32
Ichthyosporidium	1
Inositol	1
Insects	23
Insulin	3
Instestine	3
Iodine	2
Irrigation	7
Kelp meal	8
Kidney	17
Lactic acid	3
Lactose (see Carbohydrates)	
Lake rehabilitation	3
Lamprey	3
Life history	40
Light	16
Limnology	14
Limnological equipment (also see Methods -- limnology)	6
Linseed meal	1
Liver	2
Lordosis	3
Lymphocystis	9
Maggots (see natural food)	
Malachite green	11
Maltose (see Carbohydrates)	
Mammals	2
Management	52
Marking	54
Meristic variations (see Anomalies	
Metabolism	27
Methods -- artificial spawning	5
Methods -- bacteriological techniques (also see Culture media)	43
Methods -- chemical analyses	41
Methods -- hatchery	163
Methods -- limnology (also see Limnology)	9
Methods -- micro-technique	27
Methods -- nematode technique	5
Methods -- staining	26

Subject	Number of References
Migration (also see Movement)	29
Mineral (also see Calcium-phosphorus and Phosphorous)	16
Mollusca	3
Monstrosites (see Anomalies)	
Mortality	73
Movement (also see Migration)	14
Myxobacteria	18
Myxosporidia	23
National Parks	3
Natural foods	16
Natural mortality (see Mortality)	
Natural propagation	13
Neascus	1
Nematodes	18
Nets, seines, etc.	3
Niacin	10
Nutrition	83
Octomitus	26
Odor (see Olfactory	
Olfactory	7
Osmosis, Osmotic	9
Oxygen (also see respiration)	44
P-aminobenzoic acid	1
Pancreas	2
Pantothenic acid	9
Parasites (many celled animal parasites)	95
Peduncle disease	2
Pellets	2
pH (see Acidity and alkalinity)	
Phosphorus (see Calcium-phosphorous)	3
Photography	1
Physiology	42
Pigmentation	19
Pituitary	14
Plankton	10
Planting fish (see Fish planting experiments)	
Plants (also see Algae)	29
PMA	16
Poisons (see Toxicants)	
Pollution	37
Pop-eye	14
Population dynamics	18
Practical diets (see Diets)	
Predation	21
Preservation (also see Collecton and preservation)	1
Production capacity	25
Propagation -- pondfish and baitfish	4
Protein	22
Proteus hydrophilus	5
Protozoa	68

Subject	Number of References
Pseudomonas	20
Psychology	10
Pyridoxine	3
Quaternary ammonium salts	6
Radioactivity	5
Rearing capacity (see Production capacity)	
Red leg	2
Red sore disease	3
Red spot disease	1
Reservoir	8
Respiration	45
Riboflavin	12
Rickettsiales	6
Roccal	6
Rotenone	15
Roughage (see Fillers)	
Rough fish	8
Salt	10
Saprolegnia invaderis	1
Saprolegnia parasitica	41
Scales	4
Schistosome dermatitus (see Swimmers' itch)	
Scoliosis	3
Selective breeding (see Methods -- hatchery and Heredity)	
Septicemia	1
Sex	1
Shelter (see Cover)	
Silicates	1
Silt	7
Slime-patch (see Blue slime)	
Slime	1
Smell (see Olfactory)	
Snow and ice	9
Soft shell	3
Sound	4
Spawning, natural (also Methods -- artificial spawning and Natural propagation)	44
Sperm	13
Spleen	4
Starvation (also see Fasting)	2
Statistics	37
Storage (see Food -- freezing, preservation and storage)	
Streptomyces	1
Sucrose (see Carbohydrates)	
Sulfa- (see Sulfonamides)	
Sulfonamides	48
Sunburn	2
Swim bladder	4
Swimmers' itch	1
Synergists	3

Subject	Number of References
Synthetic diets	2
Tagging (see Marking)	
Taxonomy	81
Temperature	78
Territory, territorial behavior	1
Thiamin	18
Thyroid	9
Toxicants	118
Trace elements (see Minerals)	
Traps (also see Methods -- hatcherys and Fish barriers)	1
Treatments (see Methods -- hatchery and Disease control)	
Trematodes	50
Trichodina	5
Trimethylamine	2
Tuberculosis	2
Tumor	9
Turbidity	5
Ulcer	24
Ultra-violet	3
Virus	12
Vision	2
Vitamin	86
Vitamin A	51
Vitamin B complex	23
Vitamin C	1
Vitamin D	3
Vitamin M	1
Weed control (see Plants)	
Weight-length relationship	25
Weirs (see Fish barriers)	
Whirligig disease	1
White blindness	2
White spot	8
Winter conditions (see Snow and ice and ecology)	
Worms	7
Xanthopterin	3
X-ray	6
Yeast	7

Each reference was indexed under at least one subject heading and most were indexed under three ormore subjects.

A copy of the current "Trout Hatchery Manual" is submitted infulfillment of the stated objective of this job.

Recommendations:

The library on trout disease and nutrition should be kept up to date as new information becomes available in the current literature. Revisions of present sections of the "Trout Hatchery Manual" should be prepared whenever significant additions to the present knowledge are reported by trout culture workers. New sections should be added to the Manual with each identification at Montana hatcheries of previously unrecognized disease or nutritional problems. The bibliography, library, and "Trout Hatchery Manual" assembled under this job form a basis to which further additions should be made as a logical obligation of the trouble-shooter work already being supported entirely by state funds. It is therefore, recommended that this study be discontinued as a Federal Aid Project and continued by state funds.

Summary:

During the first three years of this study, early attempts to conduct controlled experiments at a production hatchery were abandoned when it was realized that considerable improvement in the Montana trout hatchery product could be accomplished through a program of education. Efforts were then made to bring the information already available in the published literature into the hands of our fish-culturists in a form more readily assimilated and applicable to their stations. It naturally followed that personal contact of project personnel with specific hatchery problems became nothing more than "trouble-shooter" work and this portion of the project was thereafter supported without benefit of Federal Aid funds.

A library of approximately 1,300 publications and a subject indexed bibliography of approximately 2,000 references were assembled and maintained during the first segment of the study with current additions from the periodical literature. The present manual contains sections on fin rot, furunculosis, gill disease, Saprolegnia parasitica, ichthyophthiriasis, octomitiasis, gyrodactyliasis, gas bubble disease, blue-sac disease, vitamin A, and appendices on composition and vitamin content of hatchery foods, and useful conversion tables. Observations made by project personnel where these diseases were identified in Montana hatcheries were included in the manual. It is written in lay-English for specific use of hatcherymen; however, extensive bibliographies are included with each section as an aid to students and interested fisheries workers.

Prepared by Jack E. Bailey Approved by _____

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