Fisheries Branch Directive	Program: Commercial Guideline Type: Management (Management, Administrative)
Subject: **STOCK MONITORING – ASSESSMENT CRITERIA** Revision Date:	Date Approved: February 5, 2007 Director, Fisheries Branch

1.0 Introduction

There are a host of stock exploitation indicators that fisheries management agencies have used including: relative yield, abundance, age structure, total mortality, mean age of the catch, variation in year-class strength, growth, and age at maturity. Given increasing interest by both management agencies and local fishers and communities in "co-management", initial attempts to provide stock monitoring criteria that were intuitive and easily understood by fishers came up with the following:

1. presence of 3 year classes at > 15% each
2. stable or increasing mean age
3. mean age of maturity < mean age of the catch

These indicators were used primarily in commercial fishery applications and if the conditions indicated were satisfied, a stock was considered stable.

Problems arise in applying these criteria to multiple use fisheries in an easily explained fashion. For example the relative nature of percent age composition can yield results that either indicate concern when there should be none, or do not indicate problems when in fact there are problems as follows:

- A single large year class could affect percent contribution of other year classes and indicate a decline in **relative** abundance of other year classes and a decrease in mean age.
- In an over-exploited fishery, three year classes in index samples might each constitute greater than 15% of the sample.

While these situations are explainable from a biologist's perspective, they can be difficult to explain and do not instill credibility if they are to be used as trigger points for management changes with users, user groups and politicians. Moreover, given increasing pressure on multiple use fisheries and Manitoba's definition of conservation as it applies to fisheries management, it is increasingly important to have direct indications of stock strength.

- "***CONSERVATION***" *is the protection of essential ecological processes and fish habitat, the maintenance of biological diversity and the harvest of fisheries resources in a sustainable fashion. Key points in meeting the protection of ecological processes include the maintenance of an adequate brood stock for propagation purposes and the adequate protection of brood stock when concentrated for spawning.*

The original three criteria are valid but are indirect in that they measure relative contribution to abundance or averages.

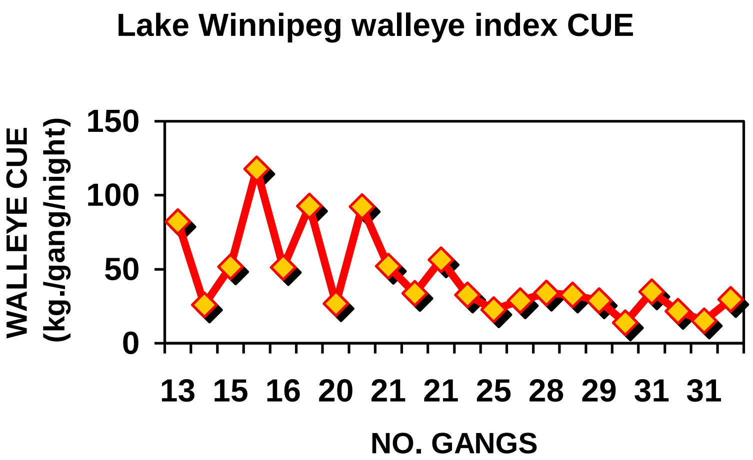
2.0 Primary Assessment Criteria

Abundance - Abundance is the most intuitive indicator and index netting is the most common fish stock assessment tool employed by fisheries managers. Therefore, CUE from a standardized (gang and location) index-netting program should be used as the key indicator of whether a stock is stable, increasing or decreasing (where sufficient index netting is performed). Given the unique productivity and harvest level of each fishery, CUE indicators will be best measured against previous years' results. Ideally, this comparison will take place over a period of a few to several years to ensure that year-to-year variation is not masking true fishing effects. In a single sample, year class variability may have a larger impact on age structure, mean age, etc. than the actual fishery. Where no previous data exist, comparison to other similar lakes and fisheries will provide some idea of stock status.

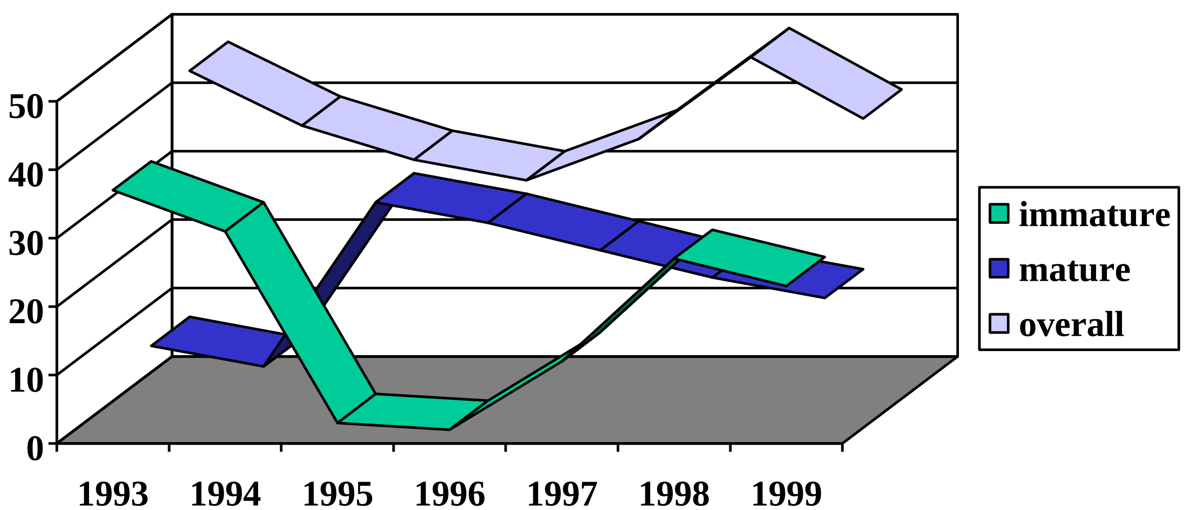
If overall CUE (number and weight) is stable or increasing, a stock will consequently be considered stable or improving. Further investigation of mature and immature CUE will still be of interest to detect potential stock status issues to track in future years, e.g. declining spawning stock abundance. If overall CUE is decreasing, the stock should be considered declining. It is important to determine whether a decline is "real" or just part of sampling variability. This is a question that managers must address based on their knowledge of the fishery and whether factors are effecting a decline. Perhaps it is reasonable to state that without knowledge of some factor that would cause a decline, or without a severe decline in CUE, that a declining CUE trend over three years would trigger cause for concern/management action

Further investigation of mature/immature CUE levels/trends should help indicate the reasons for the decline and what management actions should be taken (e.g. reduced quotas, mesh size changes, and/or conservation closures if spawning stock is in decline). In assessing the status of brood stock, abundance of female brood stock may be more relevant than CUE of combined mature male and female fish. Biologically, mature females are more critical than mature males and since there are sex-specific differences in gear selectivity and seasonal vulnerability, it may be worth further assessment to determine the relative status of mature female fish and any associated fish stock implications.

Considerations - For obvious reasons, in order to make comparisons with previous years CUE indicators, it is essential that the gear used in the index-netting program be consistent. It is also important that sufficient gang sets be made in order to be confident that the estimated CUE is representative of the actual abundance. If it is uncertain whether sufficient index netting gangs have been set, additional sets should be made for at least one year to determine the level of effort (i.e. number of sets) required to reach an acceptable level of precision of CUE estimates (see below). Since a minimum of three sets is required to calculate a variance (required for determining statistical significance of trends), this is therefore the minimum number of sets that should be performed.



Presented below is a graphical representation of Dauphin Lake walleye CUE. The graph shows that while overall CUE is relatively high, the CUE of mature walleye is declining and may be cause for concern in the future. Of interest is the decline of immature walleye CUE in 1995 associated with a sudden increase in CUE of mature fish. This is due to the maturation of a single strong 1990-year class.



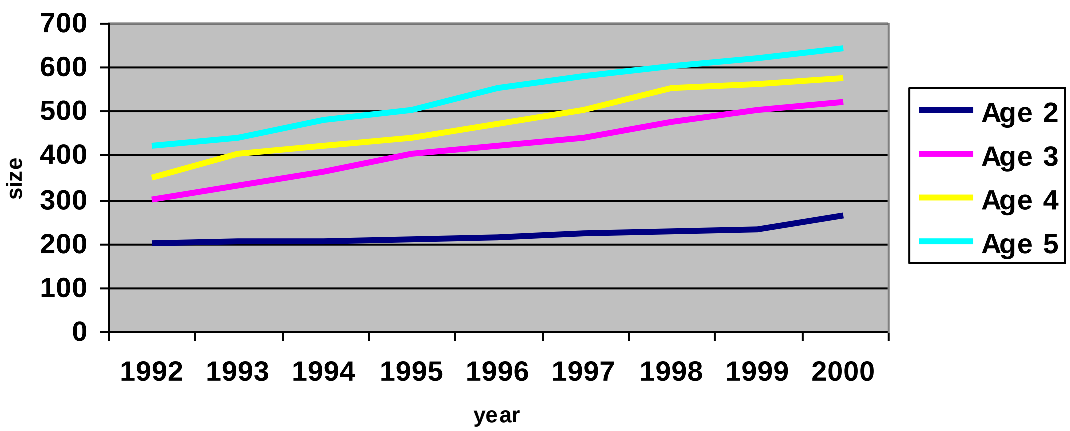
<u>CUE from Commercial Catch Data</u> - Where insufficient index netting sets can be made due to operational resource constraints (e.g. insufficient funding for adequate numbers of index net sets in large commercial fisheries), it may be appropriate to use commercial CUE from the Freshwater Fish Marketing Corporation (FFMC) commercial production database (i.e. kgs/delivery). For obvious reasons, in order for this to be a reliable estimate of catch per unit effort, the FFMC must consistently be the purchaser of the **vast majority** of fish harvested. The major weakness in commercial CUE (kg/delivery) arises from any market-related factors that might cause increased or decreased effort on the species of concern from year to year (e.g. historical declines and recent increases in lake whitefish prices).

It is important to have an understanding of fleet dynamics to be confident about the interpretation of CUE estimates from commercial deliveries. For example, if the fleet is a relatively homogenous group in terms of vessels, gear and behaviour, then deliveries will be largely consistent from fisher to fisher and the estimated CUE will represent individual fishers' CUE. If the fishery is composed of fishers that differ in vessel, gear or behaviour, but these differences are consistent from year to year, CUE will represent the fishery's performance but may not reflect any given fisher's performance. In this instance CUE estimates from year to year should be comparable but fishers may not relate well to the indicated level of harvest. However, if fleet dynamics change from year to year in response to factors like market fluctuations (e.g. whitefish prices), then comparing kilograms/delivery from year to year becomes less reliable. In these instances it becomes more important to look at other, more indirect stock exploitation indicators in addition to observed CUE trends. Stock status determination is then more of an assessment of the following, more circumstantial, indicators.

3.0 Secondary Assessment Criteria

Other exploitation indicators include:

<u>Growth</u> – As an indicator of stock status, increased growth of fish associated with increased harvest assumes that growth is density-dependent and results from a reduction in the sharing of food resources amongst remaining fish (i.e. reduced intra-specific competition leaves more food per fish). Given a constant environment this is a reasonable assumption, however it is also possible for growth to increase due to an increase in food supply. Short-term food supply increase may arise from favourable environmental conditions (temperature, warming rate, flows/water levels). Longer-term increase in forage is unlikely without some external perturbation (eutrophication, aquatic species transfers, etc.) and brings with it a destabilizing effect on the aquatic ecosystem that could effect fish stock and long-term fishery stability.



In order to determine growth rates with sufficient precision it is important to collect a sufficiently large sample size (n=250). Comparisons are most easily made by comparing size at age over time within a lake, to determine whether fish are larger at any given age than they were previously. (For example, see graph above). However, although increased growth can be identified, and statistically documented (i.e. slope of the lines in the above graph), "it is difficult to use a specific rate or even a change in a rate to detect and quantify precisely the level of exploitation" (SPOF, 1983). Quantification of exploitation from growth rates

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beyond merely identifying increased growth may only be possible by comparing to maximum observed growth rates in similar fish stocks (e.g. similar growing season) that have been overexploited (e.g. walleye in Lake Winnipegosis, Shoal Lake).

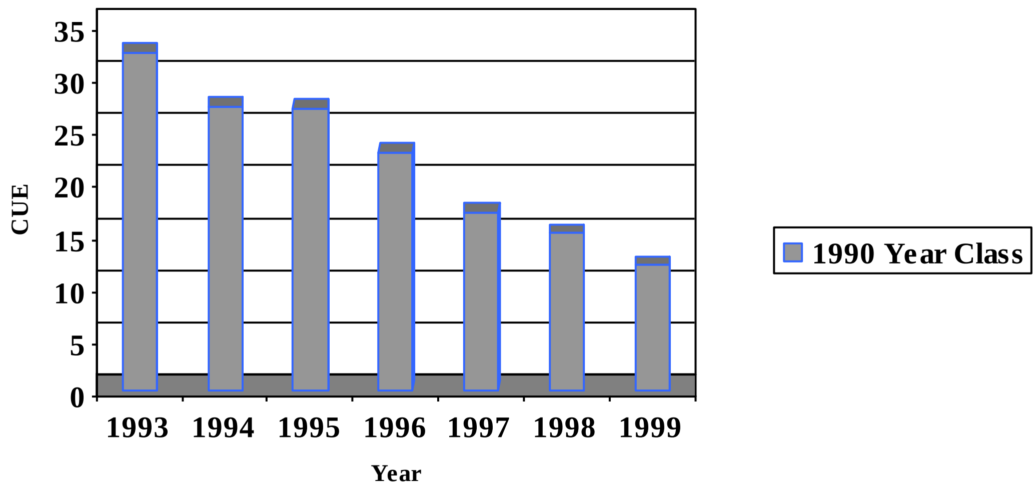
Age Class Contribution – Fish stocks supported by multiple year classes are more stable than those supported by only one or two year classes. The traditional standard for a fish stock to be considered relatively healthy was the presence of three or more year classes, each contributing at least 15% to the stock. This tends to assure managers that that some escapement is occurring and is likely to continue to occur, to support the key ecological process of spawning.

Mean Age at Maturity – For the same reasons that growth increases with reduced abundance, fish mature at a younger age when there is less intra-specific competition and resources are relatively more plentiful. Detection of declining age at first maturity indicates that harvest rates are impacting the fish stock. While earlier maturity can be identified, like growth, quantification may only be possible by comparing observed age at maturity in similar fish stocks that have been overexploited.

Mean Age of Fish Stock – By itself, this indicator serves "as a measure of the average length of time that fish remain in a population" (SPOF, 1983) and is somewhat dependent on the mesh size composition of the index gang. Mean age from index netting is useful in determining trends in multiple mesh fisheries as the typical pattern for high-priced fish species is to harvest increasingly younger, smaller fish as larger fish become scarce. Provided sampling is done with consistent gear from year to year, a trend towards decreasing mean age from index gangs would support the need for management action (e.g. small-mesh harvest tolerances to ensure that recruitment over-fishing does not occur).

Mortality – The instantaneous rate of fishing mortality, specifically, F_{msy} (corresponding to the maximum sustainable yield) is important internationally as a performance target associated with the implementation of Precautionary Approaches to fisheries management (Hillborn et. al., 2001). However, because total mortality (***A*** – annual expectation of death expressed as a decimal less than one or percent) is most critical with respect to stock sustainability, is most easily understood and is most easily measured, it is the preferred stock monitoring indicator.

While the optimal method for determining mortality is from assessment of individual cohorts captured in standard gill net gangs over their life span (see example below), many lakes are not sampled annually. Consequently mortality estimates based on the descending limb of a catch curve are the best estimate available. When calculating mortality in this fashion it is important to consider that a single year sample can lead to skewed estimates of mortality based on the exaggerated contribution of strong year classes or the scarcity of poor year classes. This means that high mortality could be surmised when in fact fish stocks are healthy and vice versa.



Clearly mortality is best assessed over the long term, by cohort, and in association with other more direct, or more quickly acquired measures of stock strength. Total annual mortality for fish stocks "bordering on high risk" was determined to be 50% for walleye, lake trout and smallmouth bass, and 60-65% for whitefish and northern pike (SPOF, 1983).

Species Composition - It is also revealing when species composition changes drastically, over time. For example a gross increase in rough fish relative abundance is typically associated with a decline in more valuable sport or commercial fishing species.

3.0 Alternative Tools

3.1 Lake Surface Area

When the only information available is the level of harvest (e.g. remote, non-monitored commercial fisheries) the surface area of the lake provides some general guidelines for determining sustainable harvest levels. For example Healey (1978) determined that for lake trout 0.5 kg/ha could be harvested and Baccante and Colby (1996) have suggested that for a walleye fishery to be sustainable, harvest should not exceed 1.0 kg/ha. Other formulas, like Ryder's (1965, 1982) MEI and Schlesinger and Regier's (1982) formula related to mean annual air temperature, are of some use in providing guidance as to what constitutes reasonable fish harvest levels. Harvests that grossly exceed the estimated sustainable production level may foreshadow impending declines. Production that is significantly below the estimates is a result of either reduced effort or reduced fish stock abundance. If low production follows years of significant harvest and similar fishing effort were expended, fish stocks are probably "declining".

3.2 Commercial Sampling

Commercial sampling is also performed and as indicated in earlier sections, mean age of harvested fish can be used in conjunction with mean age in the index netting sample to determine if fish are on average spawning before they are recruited to a commercial fishery. Traditional fisheries management approaches suggest that a commercial fishery is sustainable if the mean age of maturity (i.e. from index nets) is less than the mean age of the commercial catch.

Literature Cited

Baccante,D.A. and P.J. Colby.1996. Harvest, density and reproductive characteristics of North American walleye populations. Ann. Zool. Fennici 33: 601-615

Healey, M.C. 1978. Fecundity changes in exploited populations of lake whitefish (Coregonus clupeaformis) and lake trout (Salvelinus namaycush). J. Fish. Res. Bd. Can. 35:945-950.

Hilborn,R., J. Maguire, A.M. Parma and A.A. Rosenberg. 2001. The precautionary approach and risk management: can they increase the probability of successes in fishery management? C. Jour. Fish. Aquat. Sci. 58:99-107.

Ryder, R.A. 1965. A method for estimating the potential fish production of north-temperate lakes. Trans. Am. Fish. Soc. 94:214-218.

Ryder, R.A. 1982. The morphoedaphic index - use, abuse and fundamental concepts. Trans. Am. Fish. Soc. 111:154-164.

Schlesinger, D. and H.A. Regier. 1982. Climatic and morphoedaphic indices of fish yields from natural lakes. Trans.Am.Fish.Soc. 111:141-150.

SPOF, 1983. The Identification of Overexploitation. Report of the SPOF Working Group Number 15. Ontario Ministry of Natural Resources. 84 pp.