CHAPTER 8. CHANNEL CHANGE INVESTIGATION PROCEDURES

INTRODUCTION

The Iowa DNR Flood Plain Section (FPS) solicits comments from the Fisheries and Wildlife bureaus on channel changes or other development which may cause significant adverse effects on the wise use and protection of water resources, water quality, fish, wildlife and recreational facilities or uses. Regulatory authority to comment is given in Environmental Protection [567] Chapter 70.5(3d). Environmental Protection [567] Chapter 71 lists the category and thresholds of when a flood plain permit is required. Criteria for permit approval are given in Environmental Protection [567] Chapter 72. Chapter 72 further describes when variances are allowed and lists streams sections where channel changes are not permitted. These rules may be viewed at: http://www.legis.state.ia.us/Rules/Current/iac/gnac/gnac2184/gna2185.pdf. Key sections of these chapters are given in Appendix A.

SUBMISSION OF A CHANNEL CHANGE APPLICATION

The United States Army Corps of Engineers (COE) and the Iowa DNR have specific and different regulatory roles designed to protect the waters within and on the State's boundaries. Protecting Iowa's waters is a cooperative effort between the applicant and the two regulatory agencies. An application package has been designed to assist an applicant in initiating the permit process with both agencies for construction, excavation or filling in a water of the state or on a floodplain. This application covers all permits needed for these types of activities. However other state and federal permit may be needed when an activity's scope of work extends beyond construction, excavation or filling in a water of the state or on a floodplain.

The applicant submits one copy of the application to the COE and two copies to the DNR to the agency addresses listed in the package. The application package is available at: http://www.iowadnr.com/other/files/jointpermit.pdf.

CHANNEL CHANGE REVIEW PROCEDURES

A DNR FPS engineer solicits for fish and wildlife comments after receiving and logging an application. This solicitation is through the Fisheries Bureau. This Bureau acts as the primary contact to coordinate a fish and wildlife response and to resolve project issues.

The Fisheries Bureau will forward an application to the appropriate fish and wildlife biologists for an investigation and to compile a report of findings. Whenever possible the request will be sent electronically. In most cases the biologist closest to the project site is responsible for coordinating a joint investigation and report. Under Chapter 70.5(3a) *Inspection:* "Agency personnel may make one or more field inspections of the project site when necessary to obtain information about the project. Submission of the application is deemed to constitute consent by the applicant for the agency staff and its agents to enter upon the land on which the proposed activity or project will be located for the sole purpose of collecting the data necessary to process the application, unless the applicant indicates to the contrary on the application." **However out of courtesy, the biologists should make an attempt to contact the applicant in order to gain permission to trespass.**

The fish and wildlife biologist team is given 30 days to investigate and submit comments. Exceptions to the 30 day requirement are allowable in the event of unsuitable site conditions. The team is expected to provide a written report on the Field Survey Form (Appendix B) and give recommendations based on investigation findings. The Fisheries Bureau will use the investigation report to compile a formal response to the FPS. The purpose of the formal response is to provide a consistent message that is statewide. The FPS engineers take the formal response seriously and will deny an application solely based on fish and wildlife comments. In addition, a permit may be altered or conditioned based on recommendations. Buffer strip mitigation requirements placed in the permit are also recorded in the property deed. The applicant is responsible to maintain mitigation requirements as described in the flood plain permit.

A recommendation to deny an application is based on irretrievable losses to fish and/or wildlife or when a species of concern (state and/or federal threatened/endangered species) is present. When a project is denied sufficient information must be provided, in the written report, as to why mitigation is not feasible and what, if any, alternatives are available to the applicant. The trend in recent years has been to deny channel change proposals except when 1) stream location is threatening a public/private road, bridge or building; or 2) when a governmental agency is proposing a project that is in the public's best interest. Flood protection is an example of a project that is in the public's best interests. Mitigating impacts to an off site location should be avoided unless it will definitely benefit fish and wildlife.

It is acceptable to propose channel modifications if they will reduce destruction of fish and/or wildlife habitat. Simply moving the channel over and away from structures or actively eroding banks and keeping the meanders nearly intact is a reasonable alternative; especially when the applicant has sound justification for altering the stream channel.

Assessment of Wildlife Species and Habitat Impacts**:**

References provided in Appendix D are available to identify channel change impacts to wildlife. When determining mitigation for wildlife losses, calculate the total area of habitat that has been lost or will be lost as a direct result of the project. This includes the lost of riparian edge along the stream. Also, that area of land that could not be farmed because of the meandered portion of the stream should be considered for mitigation (Figure 1). Be specific and accurate in determining these losses.

Also be specific when giving mitigation recommendations. State the number of acres to be replace, the location of these acres, species of shrubs to be planted, and the type of grass to be seeded. Mitigation to replace habitat loss must be on land void of beneficial habitat to wildlife.

Assessment of Fish Species and Habitat Impacts:

References provided are available to identify channel change impacts to fish. Fisheries mitigation should be required as a minimum on any project which adversely impacts game fish species and sensitive species (channel catfish, smallmouth bass, Topeka shiner, etc.). Mitigation for forage fish, (suckers, minnows, darters) should be based on their importance to game fish populations in the project area and in association with larger streams. Assessment of project impacts to other aquatic species such as mussels should be considered when making mitigation recommendations. Wherever in-stream mitigation is requested, be sure to describe the number and type of structures (gabions, riffles, bank armoring, etc) recommended. Keep in

mind that a structure can not impede stream flow and fish movement. Leaving the old channel unfilled should never be considered as mitigation. These areas rapidly fill with sediment and lose their value to aquatic life. A pilot channel proposed to serve only during flood events is not to be considered. This type of channel may eventually erode and begin serving as the principle channel. To prevent stream bed degradation, a proposal in which stream bed elevation is lower at the upstream or downstream end of the channel change should always be denied.

Assessment of Fish and Wildlife Losses for Unauthorized Projects:

In order to assess the losses incurred during unauthorized projects, we need to know what was previously present. Our only recourse in these cases is to work off the latest aerial photos plus taking notes of similar habitat types immediately upstream and down stream of the project area. The least we can do on unauthorized project is to try to mitigate fish and wildlife losses. The most we can do is to restore flow to the original channel if the old channel remains open. It is very difficult to have the stream restored its original channel without solid information. However we have been successful in doing so.

When fisheries mitigation is needed for authorized or unauthorized projects, we suggest a combination of one or more of the following methods: 1) rock riprap along the toe of banks and in areas of the streambed; 2) installation of in-stream devices such as riffles or deflectors to create pool areas; and 3) some channel realignment.

APPENDIX A

CHAPTER 70
SCOPE OF TITLE—DEFINITIONS—FORMS—RULES OF PRACTICE
"Channel change" means either (a) the alteration of the location of a channel of a stream or (b) asubstantial modification of the size, slope, or flow characteristics of a channel of a stream for a purpose related to the use of the stream's flood plain surface rather than for the purpose of actually using the water itself, or putting the water to a new use. (NOTE: Diversions of water subject to the permit requirements of Iowa Code sections 455B.268 and 455B.269 usually are not channel changes.) Increasing the cross-sectional area of a channel by less than 10 percent is not considered a substantial modification of the size, slope, or flow characteristics of a channel of a stream.

"Protected stream" means a stream designated by the department as a "protected stream" in 567—Chapter 72.

"Stream" means a water source that either drains an area of at least two square miles or has been designated as a protected stream in 567—Chapter 72.

567—70.4(17A,455B,481A) Requesting approval of flood plain development.
70.4(1) *Development needing approval*. Any development in a floodway or flood plain which exceeds the thresholds in 567—Chapter 71 and is not otherwise regulated by a department flood plain management order or a department-approved, locally adopted flood plain management ordinance requires a department flood plain development permit.

70.4(2) *Applying for a flood plain development permit*. Application for a flood plain development permit shall be made on DNR Form 36 or a reasonable facsimile thereof. The application shall be submitted by or on behalf of the person or persons who have or will have responsibility by reason of ownership, lease, or easement for the property on which the project site is located.

The application must be signed by the applicant or a duly authorized agent. Completed applications along with supporting information shall be mailed or otherwise delivered to the Flood Plain Management Section, Environmental Protection Division, Iowa Department of Natural Resources, Wallace State Office Building, Des Moines, Iowa 50319.

70.5(3) *Project investigation*. The department shall make an investigation of a project for which an application is submitted. The following are standard procedures for an investigation of an application.

c. Solicitation of expert comments on environmental effects. For channel changes or other development which may cause significant adverse effects on the wise use and protection of water resources, water quality, fish, wildlife and recreational facilities or uses, the department shall request comments from the fish and wildlife division of the department or other knowledgeable sources.

CHAPTER 71
FLOOD PLAIN OR FLOODWAY DEVELOPMENT—WHEN APPROVAL IS REQUIRED

567—71.2(455B) Channel changes. Approval by the department for the construction, operation, and maintenance of channel changes shall be required in the following instances.

71.2(1) *Rural areas.* In rural areas:
a. Channel changes not otherwise associated with road projects in or on the floodway of any stream draining more than 10 square miles at the location of the channel change.
b. Channel changes associated with road projects in or on the floodway of any stream draining more than 10 square miles at the location of the channel change whereby either (i) more than a 500-foot length of the existing channel is being altered or (ii) the length of existing channel being altered is reduced by more than 25 percent.

71.2(2) *Urban areas.* In urban areas channel changes on any river or stream draining more than 2 square miles at the location of the channel change.

71.2(3) *Protected streams*. Channel changes at any location on any river or stream designated as a protected stream pursuant to division III of 567—Chapter 72.

71.2(4) *Channel change by drainage district*. Rule 72.2(455B) applies to channel changes sponsored by a drainage district. However, approval is not required for repair and maintenance of a drainage district ditch as defined in 70.2(455B) if the drainage area of the ditch at the location of the proposed work is less than 100 square miles.

CHAPTER 72
CRITERIA FOR APPROVAL

567—72.2(455B) Channel changes. The following criteria shall apply to channel changes.
72.2(1) *Percent reduction in length.*

a. Streams draining over 100 square miles. For streams (other than protected streams) draining more than 100 square miles, no more than a 10 percent reduction in the original length of the existing channel through any contiguous parcel(s) of the applicant's(s') property will be allowed.

b. Rural streams draining 10 to 100 square miles. For streams (other than protected streams)

draining between 10 and 100 square miles in rural areas, no more than a 25 percent reduction in the original length of the existing channel through any contiguous parcel(s) of the applicant's(s') property will be allowed.

c. Urban streams draining 2 to 100 square miles. For streams (other than protected streams) draining between 2 and 100 square miles in urban areas, no more than a 25 percent reduction in the original length of the existing channel through any contiguous parcel(s) of the applicant's(s') property will be allowed.

d. Protected streams. For protected streams no channel changes will be allowed, because of actual or potential significant adverse effects on fisheries, water quality, flood control, flood plain management, wildlife habitat, soil erosion, public recreation, the public health, welfare and safety, compatibility with the state water plan, rights of other landowners, and other factors relevant to the control, development, protection, allocation, and utilization of the stream. Protected stream status does not prohibit bank stabilization measures; tree maintenance or removal; maintenance or installation of tile outlets; machinery crossings, including concrete drive-throughs and bridges; boat or canoe ramps; or other structures permitted by the department; nor restrict riparian access to the protected stream for such uses as livestock watering or grazing. Protected stream status does not affect current cropping practices or require the establishment or maintenance of buffer strips, filter strips or fences along protected streams.

72.2(7) *Fish and wildlife habitat and public rights.* The channel change shall not have a significant adverse effect on fish and wildlife habitat or public rights to use of the stream. Conservation easements and other conditions may be required to mitigate potential damages to the quality of water, fish and wildlife habitat, recreational facilities, and other public rights.

72.2(8) *Soil erosion.* The tillage of land along the reach of a straightened stream shall be prohibited or modified when necessary to hold soil erosion to reasonable limits. Zones of land in which tillage shall be prohibited along the straightened reach shall be set on a case-by-case basis with consideration given to topography, soil characteristics, current use, and other factors affecting propensity for soil erosion. The tillage prohibition shall be recorded by the department in the office of the appropriate county recorder and shall run with the land against the applicant and all successors in interest to the land subject to the prohibition.

72.31(2) *Channel change variances.* The department may grant variances to the criteria stated in this chapter for channel changes (other than channel changes on protected streams) only in the following instances:
(a) For comprehensive flood control projects in urban areas where channelization is the best alternative available;
(b) for public projects such as roads or road grade protection where a channel change is the only reasonable and practicable alternative;
(c) in cases whereby natural channel erosion has significant probability of eroding the structural stability of a building or other structure and bank erosion control measures are not feasible or practical under the circumstances;
(d) in other cases where the applicant can clearly show that there are no adverse effects on the public interest.

72.31(3) *Protected stream channel change variance*. The department may grant variances to the prohibition of channel changes on protected streams for those cases listed in 72.31(2)*"b," "c,"* and *"d,"* but such variances will be with provisions for mitigation of environmental damage.

567—72.32(455B) Protected stream information. The following describes the variance procedure and the relation of hydrologically connected streams to protected streams:

72.32(1) *Protected streams variance procedure.* The variance shall be requested as part of the permit application and review process provided for in rules 567—70.3(17A,455B,481A) to 70.5(17A,455B,481A) and decisions on the variance request may be appealed in accordance with rule 567—70.6(17A,455B,481A). If the applicant is denied a permit to channelize a protected stream, the applicant may appeal to the environmental protection commission. The appeal will normally be heard by an administrative law judge but the applicant may request that the commission hear the appeal directly. If a proposed decision of an administrative law judge would affirm the denial of the permit, the applicant may appeal the administrative law judge's decision to the commission. If, on appeal, the commission affirms the denial of the permit, the applicant may appeal to the district court.

72.32(2) *Hydrologically connected streams.* Streams or waters that are hydrologically connected to protected streams are not protected streams unless specifically listed as protected streams in 72.50(2). The environmental protection commission considers the streams and waters that are hydrologically connected to streams proposed to become protected streams as one of the factors in the decision-making process to add streams to the list of protected streams in a rule-making procedure. Subrule 72.51(7) lists the other factors that affect the decision.

72.32(3) *Protected stream activities.* Protected stream status does not prohibit bank stabilization measures; tree maintenance or removal; maintenance or installation of tile outlets; machinery crossings, including concrete drive-throughs and bridges; boat or canoe ramps; or other structures permitted by the department; nor restrict riparian access to the protected stream for such uses as livestock watering or grazing. Protected stream status does not affect current cropping practices or require the establishment or maintenance of buffer strips, filter strips, or fences along protected streams except as may be required to mitigate environmental damage associated with a channel change on a protected stream.

567—72.50(455B) Protected streams.

72.50(1) *Protected streams defined*. Protected streams shall include streams designated as protected streams pursuant to the procedures of 72.51(455B), which upon designation will be listed in 72.50(2). Streams hydrologically connected to protected streams are not protected streams unless specifically listed as protected streams in 72.50(2).

72.50(2) *List of protected streams.* Streams designated as protected streams are listed in this section.

72.51(7) *Basis for protected stream designation*. Commission determination of whether or not to classify a stream as a protected stream shall be based on the balancing of the costs and benefits of possible flood plain development as it would affect the following factors: (a) maintenance of stream fishery capacity; (b) water quality preservation; (c) wildlife habitat preservation; (d) flood control; (e) flood plain management; (f) existing flood plain developments; (g) soil erosion control; (h) the needs of agriculture and industry; (i) the maintenance and enhancement of public recreational opportunities; (j) the public's health, welfare and safety; (k) compatibility with the state water plan; (l) property and water rights of landowners; (m) other factors relevant to the control, development, protection, allocation,
and utilization of the nominated stream and water hydrologically connected to it.

APPENDIX B

Stream Channel Change Investigation
Field Survey Form

Date: _____

Applicant: _____

Stream: _____ County: _____

Legal Description_____

Description of Project Area
Topography_____
_____

Drainage Area: _____ Stream Distance_____

Ave. Channel Width _____ Ave. Water Depth_____ Max. Water Depth_____

Bottom Substrate Type_____

Stream Type: Intermittent ___ Permanent ____ Warmwater ____Coldwater ____

Confluence with_____within_____miles

Cover types associated with stream corridor _____
_____
_____
_____
_____

Instream habitat types: _____
_____
_____
_____

Fish and Wildlife species frequenting or inhabiting the stream (list and describe abundance-rare, moderate, abundant) _____
_____
_____
_____
_____

Describe Channel Change Proposal _____
_____
_____

_____
_____

Fish and Wildlife Impacts _____
_____
_____
_____
_____

Project Alternatives _____
_____
_____
_____
_____

Staff Recommendation:
Deny Application: (give justification) _____
_____
_____
_____
_____

Accept Application with mitigation or without mitigation (circle one and give justification for mitigation) _____
_____
_____
_____
_____

Fish Biologist_____ Wildlife Biologist_____

Figure 1. Area of land that could not be farmed because of the meandered portion of the stream that should be considered for mitigation .

REFERENCES

A Study of the Effects of Stream Channelization and Bank Stabilization on Warm Water Sport Fish in Iowa. Subproject No. 1 -- Inventory of Major Stream Alterations in Iowa. Ross V. Bulkley, Iowa Cooperative Fishery Research Unit, Iowa State University, Ames

> "When settlers first broke the prairie sod, it is reasonable to assume that from 1,000 to 3,000 more miles of stream existed in the state than are present today." Since 1900 estimates of stream loss for the Missouri River drainage are 1,240 miles and for the Mississippi River drainage 1,775 miles.

Subproject No. 2 A Study of the Impact of Selected Bank Stabilization Structures on Game Fish and Associated Organisms. Arthur L. Witten and Ross V. Bulkely**.**

> Four types of bank stabilization structures installed mainly for highway protection -- revetments, retards, permeable jetties, and impermeable jetties -- were studied during the summer and fall of 1974 to determine their impact upon game fish habitat in Iowa streams.
>
> "Stream alterations can have great impact on fish populations by reducing cover (logs, overhanging banks, etc.) increasing sediment carrying capacity, and eliminating pools and riffles. Pools are necessary for the survival of fish in some streams, particularly in the late summer low-water period. Additionally, the change in substrate caused by channelization may drastically reduce populations of fish food organisms and hinder their re-establishment."
>
> "Permeable jetties and retards deepened the channel near the structures."
>
> "Two factors, the short length of the jetties and the small diameter of rocks used, limited the value of bank stabilization jetties studied in improving the stream habitat for game fish. None of the jetties projected more than a few meters into the stream. To significantly improve game fish habitat, jetties should extend at least one-third stream width out into the channel. Longer jetties cause the formation of larger scour holes and backwaters, and thus increase habitat diversity."
>
> "Large-diameter boulders (greater than one cubic meter) would have increased habitat diversity more than the smaller diameter rocks found in the structures studied. Large boulders create backwater and slow-water pools along the bank, and fish use the resulting eddies for cover and nesting. In contrast, small rocks provide better bank stability and are hydraulically more efficient, but have much less effect on fish habitat."
>
> "The rock structures studied fostered the growth of certain invertebrates (notably mayflies and caddis flies), and these same invertebrates were a significant part of the diet of game fish found near the structures. The small impermeable jetties, however, seemingly did not present enough rock substrate to make a significant difference in invertebrate abundance. The much more extensive rock revetments presented enough rock substrate to support abundant rock-dwelling invertebrates."
>
> "A long rock jetty, extending far enough into the stream to produce a scour hole, would combine most of the advantages noted in the structures studied. From the standpoint of

habitat improvement, rock seems superior to steel as a construction material, and structures which cause the formation of scour holes superior to those which do not deepen the stream."

Subproject No. 3 -- Some Effects of Short-Reach Channelization on Fishes and Fish Food Organisms in Central Iowa Warm-Water Streams. Lawrence Robert King and Kenneth D. Carlander.

Six central Iowa steams were studied in 1974 to determine whether fish and fish food organisms were affected by short-reach channelization associated with bridge replacement in the last 15 years.

"More fish species were collected by electroshocking in unchannelized than in channelized locations in five of the six streams and in the sixth the number of species was the same in both localities. The most evident impact of short-reach channelization is the removal of cover in the altered area and the loss of stream length."

Subproject No. 4 -- The Effects of Long-Reach Channelization on Habitat and Invertebrate Drift in Some Iowa Streams. David William Zimmer and Roger W. Bachman.

"Relationships between channel morphometry, habitat diversity, and invertebrate drift density were studied in 11 natural and channelized stream segments of the upper Des Moines River Basin during 1974 and 1975. The most obvious effect of channelization on stream habitat was a reduction in the diversity of water depth and current velocity. There was a significant (P=.05) positive correlation between channel sinuosity and the variability of stream depth and velocity. Invertebrate drift density, expressed as biomass and total counts, was also correlated with channel sinuosity. Sinuous streams had greater concentrations of drifting organisms than did straight channels. The impact of channelization on habitat diversity and invertebrate drift density might be minimized if channels were designed with greater sinuosity index values.

Effects of Stream Channelization of Fishes and Bottom Fauna in the Little Sioux River, Iowa. Completion Report No. A-035-IA Iowa State Water Resources Research Institute. Douglas R. Hansen and Robert J. Muncy.

Differences in certain physical factors, bottom fauna, and fish populations were evaluated in channelized and unchannelized portions of the Little Sioux River, Iowa, during 1969-71.

"Recorded water temperatures showed greater daily fluctuations during summer in the channelized section. Maximum and mean daily water temperatures averaged 0.3C and 1/3C, greater, respectively, in the channelized section during July. Consistently higher turbidities were measured in the channelized section during a period of low runoff, averaging 31.2 percent higher than the unchannelized section."

"Removal of stream bank cover was an important factor contributing to such conditions as higher water temperatures and higher suspended sediment loads from channel erosion in the channelized section. Higher maximum and mean daily water temperatures could approach upper lethal levels of such species as walleye."

An Evaluation of Steam Modification in the Olentangy River, Ohio, Clayton J. Edwards, Bernard L. Griswold, and Gary C. White.

"Comparisons of fish species composition and relative, abundance were made between a natural section of the Olentangy River, Ohio; a section modified in 1970 by the construction of artificial riffle-pool structures; and a section modified conventionally in 1950 by shortening, widening, and deepening the channel. Thirty-six species ere collected in the natural area, 34 in the riffle-pool area, and 28 in the conventionally modified area."

Effects of Channel Modification of the Luxapalia River, Dale H. Arnen, H. R. Robinette, John E. Fraiser, and Marion Gray.

"Biological data collected over a period of two years from an old channelized segment, an unchannelized segment, and a newly channelized segment revealed the following: There were no evident differences in water Quality between the three segments with the exception of turbidity which was higher in the newly channelized segment. Species diversity of macroinvertebrates and fish was much greater in the unchannelized segment. Average weight of largemouth bass was much greater in the unchannelized that either of the channelized segments."

"Studies of abundance of furbearers associated with the river were obtained by night-lighting, sign count, and trapping. Muskrat and beaver were far more numerous in the unchannelized segment than in either the old or new channelized segments."

Channeling is detrimental to wildlife. The combination of channeling and tiling allows for more intensive farming of floodplain areas. Wildlife losses occur as the habitat diminishes. Wildlife population is directly related to the amount of interspersion of cover, or amount of "edge". Edge can be defines as the zone where tow types of cover comes together, such as where food and nesting cover meet.

In channeling a stream the linear length of the stream is reduced as is the amount of edge.

Aldo Leopold, in his book of Game Management, review edge as follows:

Game as an Edge-effect; Law of Interspersion. Game is a phenomenon of edges. It occurs where the types of food and cover which it needs come together, i.e.; where their edges meet. Every grouse hunter knows this when he selects the edge of a woods, with its grape tangles, haw-bushes, and little grassy bays, as the likely place to look for birds. The quail hunter follows the common edge between the brushy draw and the weedy corn, the snipe hunter the edge between the marsh and the pasture, the deer hunter the edge between the oaks of the south slope and the pine thicket. Even the duck hunter sets his stool on the edge between the tules and the celery beds. Wight finds that pheasants nest in the outer edge of the hayfield where it adjoins the fencerow; the Grouse Report finds that grouse nest on the edge where the young heather adjoins the old; Stoddard and Maxwell say that bobwhite and Hungarian partridge often choose the edges of open roads or trails for nesting. Even wild turkeys show a curious tendency to nest at the edge of trails. We do not understand the reason for all of these edge-effects, but in those cases where we can guess the reason, it usually harks back either to the desirability of simultaneous access to more than one environmental type, or the greater richness of border vegetation, or both."

"It will also be observed that edge-effects are most numerous in game of low mobility and high type requirements. I know of few convincing instances where edges attract mobile, one-type game like geese, or buffalo, or antelope, or plover, or sea-ducks."

"The linear mileage of type edges available in any block of range is, as a matter of geometry, proportional to the degree of interspersion."

Reuben E. Trippenser, in Wildlife Management of Upland Game and General Principles, reviews interspersion or diversified cover.

Food and Cover Development. The successful propagation of quail in their natural habitat depends upon the development of a diversified cover, which for best results should contain cropland, grassland, brushland, and woodland in about equal proportions and will distributed in small units. Diversification effects a more nearly uniform distribution of coveys, discourages wandering, and improves productivity. Where diversification is lacking, the birds tend to migrate locally to more attractive habitat elsewhere.

"Extensive areas of cropland in large continuous units can be greatly improved as a quail habitat by the development of cover lanes, or strip that traverses the tract at intervals. These lanes encourage the quail to make use of range previously avoided because proper approach and escape cover were lacking. In a habitat of this nature suitable cover is sparse and often widely scattered in small islands entirely isolated from similar units. Here the problem is one of providing safe avenues of travel along which the birds can move from one cover unit to another or to spots in the adjacent fields or cropland where food is plentiful."

Fish Populations of Iowa Rivers and Streams. Technical Bulletin No. 3 Vaughn Paragamian, Iowa Department of Natural Resources, May 1990

"Total standing stocks ranged from 10.9 lbs/ac in a channelized reach of the Chariton River (Southern Iowa Drift Plain) to almost 2,300 lbs/ac in the East Fork Des Moines River (Des Moines Lobe). Analysis of variance comparisons of the means showed habitat quality was the main factor for significant differences ($P<0.05$) between total standing stocks of fish. Further comparisons indicated there was no difference in total standing stocks of fish within and between landforms. Altered streams had significantly lower standing stocks of fish ($P<0.05$) than unaltered sites. Headwater streams were important to sport fish, while habitat quality and diversity was the most important factor to fish abundance and biotic diversity."

"Cylinder Creek, a ditched stream in the Des Moines Lobe, was uniform in depth, substrate, current velocity and thus provided little habitat to fish."

"The importance of headwater streams to sport fish populations of larger rivers is not well documented, but 86% of the smaller second and third order streams were inhabited by young-of-the-year of one or more species of sport fish important to the fisheries of larger receiving streams. These small streams appear to be important spawning and nursery sites for sport fish that may later recruit to larger streams; however, a better understanding of this relationship is needed."

An Evaluation of Effects of Weirs in Walnut Creek, Seven Mile Creek, and Turkey Creek on Fish Abundance and Movement, Completion Report to the Iowa Department of Natural Resources

Fisheries Bureau Contract No: 01-8250-02, Chris J. Larson, Gary J. Atchison, and Bruce W. Menzel, February 2003.

> "Fish population sampling efforts in southwest Iowa tributary streams indicate a lack of species diversity and reduced gamefish populations following 11 years of grade control weirs constructed in streams to control erosion. Over 400 of these weirs have been constructed in this region since 1992, yet 400+ more are proposed or under construction. Most of the structures are of one design, involving a 4 foot high sheet piling dam and a 4:1 (length: height) back slope constructed of rock rip-rap. In 2000, Iowa Department of Natural Resources (IDNR) fisheries personnel, in conjunction with Iowa State University (ISU) Natural Resource and Ecology Department, and Hungry Canyons Alliance (HCA) implemented a 2-year study on the effects of modified and unmodified grade control weirs on fish population dynamics and movement. The study was conducted on three southwestern Iowa tributary streams. The lowermost six weirs on Walnut Creek were modified from 4:1 back slopes to 20:1 back slopes during the winter of 2000-2001. The existing 4:1 weirs in Turkey Creek and Seven Mile Creek were not modified. Personnel from the ISU began studying fish movement patterns in selected stream reaches from May through July of 2001 and 2002. Hoop nets and minnow traps with used to capture fish at predetermined sites. Selected species were monitored using mark and recapture techniques. All channel catfish, bullheads, flathead chubs and creek chubs were marked with site specific fin clips or tags for subsequent recapture information and movement analysis. Results of the two-year study indicate some bi-directional movement of channel catfish and flathead chubs over 20:1 modified weirs with very limited movement for all species over 4:1 weirs."
>
> "Numerous studies have been conducted on the possible impacts on fish populations from restricted fish migration opportunities. Dams and weirs have been implicated in the decline of numerous fish species. Potential consequences of restricted up or downstream fish passage include the disruption of migration behavior and reproductive activity and impeded access to foraging and wintering areas. These factors may combine to limit growth, recruitment, overwinter survival, and population size (Wlosinski et al, 2000, Dames et al, 1989). As more of these structures have been built, a concern has developed that these stream blockages have promoted decline of migratory fishes."

Recovery of Prairie Fish Assemblages at the Transition from Channelized to Nonchannelized: Implications for Conservation of Natural Channels, Jason C. Vokoun, Natural Areas Journal Volume 23 (4), 2003.

> "Fish assemblages were systematically sampled along the transition from channelized to unchannelized reaches in seven streams in northern Missouri, USA. Streams ranged in size from 4th to 8th order. Maximum species richness was reached 3-4 km downstream from the end of channelization. A limited core group of 10 species was present at most of the sites (channelized and unchannelized locations), and a diverse group of 45 species was present at relatively few sites (rarely channelized locations). The core group consisted largely of tolerant, omnivorous species and contained no top carnivores. The 45-species divers group included a greater proportion of intolerant, benthic invertivorous, lithophilous, and carnivorous species. The effect of channelization extended well into unchannelized reaches and should be considered by conservation planners."

Downstream Natural Acres as Refuges for Fish in Drainage-Development Watersheds, James E. Luey and Adelman, Ira R., 1980. Transactions of the American Fisheries Society, 109:332-335

> "Agricultural drainage development in southwestern Minnesota involves installation of tiles to drain subsurface water, creation of tributary ditches, and channelization of existing streambeds. The presence, abundance, and diversity of fishes collected in downstream unmodified areas of drainage-developed and undeveloped streams indicate that any downstream impacts are much less severe than impacts demonstrated by others within developed areas. These natural areas appear to serve as reservoirs for stream biotas and should be preserved as refuges for fish species inhabiting those streams."

Mitigating Effects of Artificial Riffles and Pools on the Fauna of a Channelized Warmwater Stream, Clayton J. Edwards, etc., 1984. American Journal of Fisheries Management, 4:194-203.

> "The effect of stream channelization on macroinvertebrates, fish, and the sport fishery was studied in the Olentangy River at Columbus, Ohio. Macroinvertebrate abundance, diversity indices, standing stock in the benthos, and drift were significantly lower in a channelized area than in either a natural area or a channelized area mitigated with artificial riffles and pools. Predominant macroinvertebrates were moving-water forms in the natural and mitigated areas, and burrowing forms in the channelized areas. Diversity indices and relative abundance of game fish were significantly lower in the channelized area than in the natural and mitigated area. However, some nongame species became relatively abundant in the mitigated area when compared to the natural area. Composition of the sport fishing catch and catch rates accurately reflected the predominant fish community in each area. The biota in the area mitigated with artificial riffles and pools was similar to the biota in the natural areas."

Standing Stocks of Fish in Some Iowa Streams, with a Comparison of Channelized and Natural Stream Reaches in the Southern Iowa Drift Plain. Vaughn L. Paragamian, 1987 Proc. Iowa Academy of Science 94(4): 128-134.

> "Comparisons were made of fish populations inhabiting 11 channelized and natural stream reaches in the Southern Iowa Drift Plain and two drainage ditches in the Des Moines Lobe. Total standing stocks of fish ranged form 14 kg/ha at a channelized site on the Chariton River to 1,344 kg/ha at an unchannelized site on the same river. Number of fish species ranges from six to 16. Channelized sites contained fewer fish and substantially lower standing stocks of fish than natural reaches; however the number of species sampled was often similar. The abundance of sport fish was significantly higher in the natural stream reaches, particularly channel catfish, flathead catfish, bullhead and carp. The major differences in fish populations were due to habitat quality and diversity found in the natural sites as compared to the homogeneous habitat of channelized reaches."

Movements of Channel Catfish and Flathead Catfish between the Missouri River and a Tributary, Perch Creek. Dames, R.H., Coon, T.G. and Robinson, J.W. 1989. Transactions of the American Fisheries Society. 118:670-679, 1989.

Fish Passage Through Dams on the Upper Mississippi River. Wlosinski, J.H. and Surprenant, C. 2000. Coordination Report (draft copy), Mississippi River Long Term Resource Monitoring Station, On Alaska, Wisconsin.